FINAL REPORT

UPDATE ECIP PACKAGE FOR BUILDING P-300

WHITE SANDS MISSILE RANGE
NEW MEXICO

Prepared for

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
FORT WORTH, TEXAS

Under

CONTRACT NO. DACA 63-91-C-0152
MODIFICATION NO. P0002

E M C ENGINEERS, INC.
Denver, Colorado
Atlanta, Georgia

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
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Librarian Engineering

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EMC #1110-000 MOD

By

E M C ENGINEERS, INC.
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Suite C-200
Denver, Colorado 80227
303/988-2951

This report has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of E M C Engineers, Inc. In preparing this report, EMC has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, E M C Engineers, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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APPENDICES

1.0 INTRODUCTION

1.1 Authority for Building P-300 ECIP Package Update

The ECIP package update for Building P-300, at White Sands Missile Range, New Mexico, was authorized by the U.S. Army Engineer District, Fort Worth, Texas under the Contract/Order No. DACA 63-91-C-0152, Modification P0002.

1.2 Purpose of Building P-300 ECIP Package Update

The purpose of updating the ECIP package for Building P-300 is to provide an ECIP package with the latest ECIP criteria (13 November 1992), including an updated DD1391 Form with backup data and to provide planning documents for the Energy Conservation Opportunities (ECOs) in this package. The purpose of the original Contract/Order No. DACA 63-91-C-0152 was to analyze the application of selected ECOs to designated buildings and systems at the White Sands Missile Range, New Mexico.

1.3 Scope of Work

The scope of work is included in Appendix A. This is summarized as follows:

- Update ECIP package for Building P-300, using the 13 November 1992 ECIP criteria, and an updated DD1391 Form with backup data.

- Provide planning documents:

  - Variable Air Volume (VAV) Retrofit: Show major ductwork changes in one-line form, hand drawn on existing plans, including location of VAV boxes, a typical mixing box demolition and replacement with a VAV box, and a brief control description;

  - Air-cooled Chiller with Water-Cooled Chiller Replacement: Show a schematic diagram of the new system indicating major components and piping changes;

  - Chilled Water Thermal Storage System: Show a schematic diagram of the new thermal storage system indicating major components, piping changes, and the approximate location of the system;

  - Fluorescent Lamps and Ballasts Replacement: Replace standard lamps fluorescent lamps and ballasts with a reduced-wattage type.

2.0 BACKGROUND

Building P-300 is the Range Control building. It houses mission elements that control the various flight tests and other missile range mission activities. The building essentially has two

types of spaces: administrative or offices, and mission equipment rooms which include various kinds of computers, display boards and scopes, control equipment, communications equipment and support equipment, such as printers, disk drives, etc. The building has two stories with a full basement and is U-shaped with a south wing (main building) and east and west wings (additions).

In November 1992, an Energy Savings Opportunity Survey (ESOS) was completed by E M C Engineers, Inc. on several buildings at White Sands Missile Range. Building P-300 was evaluated for the following eight Energy Conservation Opportunities (ECOs):

- Use more efficient lighting fixtures.
- Reduce lighting levels.
- Use recovered waste heat.
- Use dry bulb economizers.
- Reduce outside air quantities.
- Use thermal storage for demand reduction.
- Convert constant volume air handling systems to variable air volume.
- Consolidate multiple air-cooled chiller (loads) onto two high efficiency, water-cooled chillers.

The annual energy use data, economic data, and ECO interactions were evaluated. As a result of the evaluation, the following ECOs were recommended:

- Convert seven air handling units and air distribution systems to variable air volume;

- Replace one air-cooled chiller with a water-cooled chiller;

- Install a 1,000 ton-hour chilled water thermal storage system;

- Replace standard fluorescent lamps and ballasts with low-wattage fluorescent lamps and ballasts.

Each of the ECOs qualified with an SIR ≥1.25, and were recommended to be implemented as an ECIP project. The ECIP Program Documentation Support Data was developed and submitted in Appendix C of Vol. I, Book 1 of the ESOS Final Report, dated November 1992.

3.0 PLANNING CONCEPTS FOR BUILDING P-300 ECIP PACKAGE

3.1 Retrofit Air Systems to Variable Air Volume (VAV) Systems

Building P-300 was designed with two types of air handling and distribution systems. Most spaces are served by both single zone air handling units (SZUs) that supply mechanically cooled air to raised floor plenums and dual duct air handling units (DDUs) ducted overhead. (The SZUs were sized to carry the equipment cooling load of the building. Space thermostats control the dual duct system mixing boxes to provide occupant control over room temperatures. The SZU discharge temperature is controlled by thermostats located under the

raised floor to maintain a 55°F plenum air supply temperature. The SZUs and the DDUs are served by constant volume air handlers.

The office spaces throughout Building P-300 are overcooled because of the lack of control of the SZUs. The DDUs provide heat when needed, or extra cooling for equipment rooms during times of high mission activity.

The planning concept for the VAV retrofit includes air handling unit static pressure controls and modifications to supply air systems. The following describes the VAV retrofit:

- The underfloor supply air ducts from the SZUs that currently serve office spaces would be closed off by capping branch ductwork. Only the DDUs would then be used to supply conditioned air to the offices.

- Controls would be replaced with DDC (direct digital controls).

- The SZU and the DDU air handlers would be converted to VAV systems with variable speed fan controllers for static pressure control.

- The existing DDU mixing boxes would be removed and new dual duct VAV mixing boxes would be installed, or VAV conversion kits would be installed in existing DDU mixing boxes.

- VAV terminal units would be installed on the SZU ductwork branches to vary the amount of supply air to the raised floor plenums.

- Space temperature would be controlled as follows:

  For spaces where only DDUs are active, space thermostats would control DDU VAV boxes.

  For spaces where both DDUs and SZUs are active, DDU VAV boxes and SZU VAV terminal units would be sequenced with the SZU VAV terminal units leading in control and the DDU VAV boxes lagging in control. This would ensure equipment cooling and satisfactory space temperatures.

  A 100% shutoff of VAV boxes would be considered in the final design.

Extensive asbestos-containing material (ACM) removal throughout Building P-300 should be done prior to construction of the VAV retrofit. ACM is located above ceiling panels as sprayed-on fireproofing. The VAV retrofit of the air ducts and mixing boxes would disturb the sprayed-on ACM. A small amount of piping also containing ACM insulation would be disturbed during construction.

The preliminary locations for the SZU ductwork modifications, the SZU VAV terminal units, and the DDU mixing box replacements with DDU VAV boxes are shown on Drawing Nos. M-1 through M-10 on pages B-4 through B-13 in Appendix B. Typical details of the existing DDU mixing box demolition and the DDU VAV mixing box installation and controls are

shown on Drawing No. M-11 on page B-14. Typical details of the SZU VAV terminal units for installation and controls are shown on Drawing No. M-12 on page B-15. The cost estimate for the VAV retrofit is presented in Appendix C.

The proposed modification would reduce fan energy consumption, provide flexibility in coping with future changes, and correct the problem of overcooling the offices.

Currently, the chilled water set point on all operating chillers is manually reset to maintain space temperatures. Depending on the weather conditions and the time of year, these adjustments may be made several times during a day. With VAV, supply air flow rates would be varied automatically to satisfy cooling loads. The chilled water set point could be fixed, or automatically reset for energy conservation.

3.2 Replace Air-Cooled Chiller with a Water-Cooled Chiller

Building P-300 is served by 8 chillers. The main building (south) is equipped with one 165 ton and one 200 ton electric centrifugal chiller, each served by a cooling tower. The existing 200 ton centrifugal chiller is 10 years old and has approximately 13 years of remaining life. The existing 165 ton centrifugal chiller is original building equipment, and is used occasionally in place of the 200-ton unit. Six air-cooled chillers are located outside between the east and west additions (four 50 ton and two 100 ton air-cooled chillers). The normal sequence of chiller use is one of the two centrifugal units plus a single 50 ton air-cooled chiller, augmented by one of the two 100 ton air-cooled units as necessary.

A computer simulation of the building baseline cooling load indicates that the load varies from a low of approximately 44 tons in winter to a summer high of 210 tons. This was generally confirmed by discussions with Comfort Zone, Inc. personnel, who operate the building HVAC systems. Seldom are more than two chillers required to meet the load.

The planning concept for this ECO is to discontinue the use of one of the two 100-ton air-cooled chillers, and install a new, 100 ton water-cooled reciprocating or scroll chiller to augment the existing 200-ton centrifugal chiller operation. The ECIP energy analysis of the combined qualifying ECOs revealed a peak cooling load of approximately 300 tons required for the operation of the chilled water thermal storage. The six air-cooled chillers would be retained for backup. The three water-cooled chillers would be served by the two existing cooling towers, since the two centrifugal chillers do not run at the same time. The following describes the installation of the new 100 ton water-cooled chiller:

- The water-cooled chiller (equipped with a protective cover) and chilled water pump would be placed on the existing concrete pad to the east of the 50 ton air-cooled chillers.

- Chilled water supply and return piping would be connected into the existing chilled water piping loop.

- A condenser water pump would be installed and condenser water supply and return piping would be connected to one of the existing cooling towers.

- A condenser water pump would be installed and condenser water supply and return piping would be connected to one of the existing cooling towers.

A schematic diagram of the new 100 ton water-cooled chiller installation is shown on Drawing No. M-13 on page B-16. The cost estimate for the new water-cooled chiller installation is presented in Appendix C.

3.3 Install Chilled Water Thermal Storage System

Building P-300 is mechanically cooled 8,760 hours per year. Because the nighttime cooling load is less than the daytime load, the excess chiller capacity could be used to charge a chilled water storage tank. The tank would provide cooling during daytime peak demand periods to reduce monthly peak electrical demand. The cooling towers and air-cooled condenser units operate most efficiently at night when the outdoor ambient wet and dry bulb temperatures are lowest. This shifting of load not only reduces daytime peak demand, but gives an overall reduction in the average kW/ton for chiller operation.

El Paso Electric Company currently pays a rebate to customers that shift on-peak chiller compressor motor loads to the off-peak period. The rebate is $190/kW based on the calculated annual design cooling load.

The planning concept for this ECO includes the installation of a chilled water thermal storage system and is described as follows:

- Provide a 1,000 ton-hour chilled water thermal storage tank that would be placed underground to the north of the 100 ton McQuay air-cooled chillers.

- Install new piping that would connect the thermal storage tank to the existing chilled water loop.

- Install control valves and a variable speed pump that would control the flow of chilled water.

- Install DDC controls that would be used to control the existing pumps, the variable speed pump, and the control valves.

A schematic diagram of the chilled water thermal storage system installation is shown on Drawing No. M-13 on page B-16. The cost estimate for the chilled water thermal storage system is presented in Appendix C.

3.4 Replace Fluorescent Lighting

Except for a small number of spot incandescent lights used infrequently during selected mission activities, the lighting in Building P-300 is a mixture of standard and reduced wattage fluorescent lamps and ballasts. Some of the fluorescent fixtures have been disconnected as part of an energy conservation program. Discussions with building area managers and electric

shop personnel indicate that the existing fluorescent fixtures are a mixture of standard and reduced wattage type. For evaluation purposes, it was assumed that one-third of the existing fluorescent fixtures are of the reduced wattage type. The locations of the reduced wattage fluorescent fixtures are unknown. For this reason, it is now recommended that the entire fluorescent lighting system be upgraded with new reduced wattage fluorescent lamps and ballasts. It is estimated that 1,245 fluorescent fixtures would be upgraded. The cost estimate for this ECO is presented in Appendix C. The calculations per building zone and the building zone layouts are presented in Appendix D.

4.0 ECIP PACKAGE UPDATE FOR BUILDING P-300

The ECIP program documentation support data were updated as follows:

- DD1391 forms were revised to include new dates, a savings-to-investment ratio, an internal rate of return, a simple payback, and the TriService Military Construction Program (MCP) Index.

- Sample calculations for the annual recurring maintenance cost savings were included for the upgraded fluorescent lighting system.

- Life Cycle Cost Analyses were updated using the latest ECIP criteria (13 November 1992).

- The cost estimate analysis, DA Form 5418-R, was updated to include cost increases for the VAV conversion, the chiller replacement, and the reduced wattage fluorescent lamps and ballasts. The Army Construction Program Cost Growth Factor was also updated.

The VAV conversion cost was increased to include 10 additional VAV terminal units with controls for the SZU air distribution system. This cost was not included in the previous estimate for the VAV conversion ECO.

The chiller replacement cost was increased to include piping, pumps, and electric power hookup. This cost was not included in the previous estimate for the chiller replacement ECO.

The lighting cost was increased to include the replacement of an additional one-third of all the fluorescent lamps and ballasts in the building. The previous cost analysis included the replacement of two-thirds of the fluorescent lamps and ballasts.

The combination of ECOs recommended for the ECIP program is referred to as the modified configuration. The annual energy use data and the economic summary for the modified configuration are presented in Tables 4-1 and 4-2 respectfully.

TABLE 4-1
ANNUAL ENERGY USE DATA

Configuration	Purchased Utilities			Elec. Energy Savings (kWh)	Average Demand Reduction (kW)	Gas Energy Savings (MBtu)
	Elec (kWh)	Elec (kW)	Gas (MBtu)			
Baseline	4,675,776	736.7	2,355	-	-	-
Modified configuration	3,285,543	551.0	1,612	1,390,233	317.8	743

TABLE 4-2
ECONOMIC SUMMARY FOR ECIP PACKAGE

Configuration	Electric Energy ($/yr)	Electric Demand ($/yr)	Gas Energy ($/yr)	Construction Cost ($)	Maintenance Cost Savings ($/yr)	Simple Payback (yrs)	SIR
Modified Configuration	30,748	71,936	1,642	524,275	5,060	5.2	2.6

The individual ECOs are backed out of the computer simulation model one at a time in order to determine the energy savings with the effects of interaction. The results are presented in Tables 4-3 and 4-4.

S_{kWh} = 1,390,233 kWh × 3,413 $\frac{BTU}{kWh}$ × $\frac{MBTU}{10^6 BTU}$ = 4,745
743
5,488 MBTU savings

$ Savings
30,734 Elec
71,936 Elec Demand
1,642 Gas
5,060 Maintenance
$109,386

TABLE 4-3
ANNUAL ENERGY CONSUMPTION DATA OF ECOS WITH INTERACTION

Configuration	Purchased Utilities			Elec. Energy Savings (kWh)	Average Demand Reduction (kW)	Gas Energy Savings (MBtu)
	Elec (kWh)	Elec (kW)	Gas (MBtu)			
Modified Configuration	3,285,543	551.0	1,612	—	—	—
VAV	4,433,935	673.7	2,373	1,164,899	67.5	761
Chiller	3,460,157	617.6	1,617	179,015	18.0	0
Thermal Stor-age	3,279,396	599.6	1,612	(6,147)	48.6	0
Lighting	3,301,940	624.0	1,585	1,373,825	73.0	(27)

TABLE 4-4
ECONOMIC SUMMARY OF ECOs WITH INTERACTION

ECO	Electric Energy ($/yr)	Electric Demand ($/yr)	Gas Energy ($/yr)	Construction Cost ($)	Maintenance Cost Savings ($/yr)	Simple Payback (yrs)	SIR
VAV	25,534	17,336	1,684	309,566	0	7.7	1.85
Chiller	3,998	4,212	0	72,893	(1,000)	11.3	1.25
Thermal Storage	(136)	25,019	0	82,500	0	3.3	4.25
Lighting	499	5,655	(61)	59,316	6,060	5.4	1.78

Each of the ECOs qualifies with an SIR $\geq$ 1.25. The ECIP program documentation support data is provided in Appendix B of this report.

APPENDIX A

SCOPE OF WORK
CONFIRMATION NOTICES

DETAILED SCOPE OF WORK
CONTRACT NO. DACA63-91-C-0152
MODIFICATION P0002

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project in accordance with the original basic contract and this Detailed Scope of Work. <u>Appendix "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work conflicts with Appendix "A", this Detailed Scope of Work shall govern.</u>

INSTALLATION	PROJECT TITLE
White Sands Missile Range	Energy Savings Opportunity Survey (ESOS)

2. The work, design, related data and services required in this contract shall be accomplished within the limitation of cost on subject project stated above and scope of work described in paragraph 3. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

	BASIC CONTRACT MODIFICATION	DELIVERY SCHEDULE
a. Preliminary Submittal(s) and Related Data or Studies (10 copies)	*	21 calendar days (after receipt of signed modification
b. Final Submittal(s) (10 copies)	*	10 calendar days after approval of the Preliminary Submittal

3. The items of work included in this modification shall be in accordance with criteria furnished. The services to be provided shall include, but not be limited to, the following:

a. Items of Work:

(1) Update ECIP package for Building P-300, using the 13 November 1992 ECIP criteria, and an updated 1391 and backup data.

(2) Install VAV. Show major ductwork changes in 1-line form, hand drawn on existing plans, including location of VAV boxes, a typical mixing box demolition and replacement with a VAV box, and a brief control description.

(3) Replace air-cooled chiller with water-cooled chiller. Show a schematic diagram of the new system indicating major components and piping changes.

(4) Install 1000 ton-hour chilled water thermal storage. Show a schematic diagram of the new system indicating major components, piping changes, and the approximate location of the system.

(5) Replace fluorescent lamps and ballasts. For each floor, identify on existing drawings, in hand-drawn form, the fixtures requiring lamp and/or ballast replacement.

b. Government Furnished Items.

(1) Existing reference material for Building P-300.

(2) Project related as-built drawings.

(3) The new Energy Conservation Investment Program (ECIP) Guidance, dated 4 & 13 November 1992.

c. Special Requirements - Distribution of submittal documents are as follows:

(1) Three copies of all documents shall be mailed to:

Commander
U.S. Army Engineer District, Fort Worth
819 Taylor Street/P.O. Box 17300
ATTN: CESWF-ED-M/Richard Champagne
Fort Worth, TX 76102-0300

(2) Seven copies of all documents shall be mailed to:

Commander
US Army White Sands Missile Range
ATTN: STEWS-EL-PE/Mr. Delgado
White Sands Missile Range, New Mexico 88002-5076

CONFIRMATION NOTICE

Confirmation No. EMC #1110-000

DATE:	25 March 1993 To/**From**: Richard Champagne PHONE #: 817/334-2750 Representing: Ft. Worth COE
PROJECT:	White Sands ESOS
CONTRACT No.:	DACA 63-91-C-0152
Prepared by:	Paul Kauffman
Subject:	Negotiation of Contract #DACA 63-91-C-0152, ESOS at White Sands Missile Range. Modification #0001, Update ECIP Package for Building P-300

The proposal was reviewed. Clarification was discussed regarding the following:

1. Site Investigations.

   Davenport stated that we believe we have all the necessary information in our files to prepare the one-line diagrams, and the mark-ups of existing drawings, and do not anticipate any site visits.

2. Type of drawings to be prepared.

   Davenport explained that we expected to mark-up copies of existing drawings for use in planning the VAV system component of the project. We will also prepare sketches of a typical mixing box changeout, and include a brief control description. Mark-ups of drawings will be done using heavy, bold lines to identify new work.

   For the chiller replacement, and thermal storage components of the project, we anticipate preparing one-line diagrams of the system components, and major piping changes.

   For the lighting replacement, we recommend a complete lighting changeout, rather than trying to identify individual fixtures for replacement. Richard acknowledged that Tom Forster and he had also discussed that, and that it may be more logical to specify a complete changeout of the fluorescent lighting.

3. Difference in "Technician" versus "CADD Operator" hours in drawing preparation.

   Davenport stated that we anticipate using a CADD Operator to prepare the necessary one-line diagrams, but will use a Technician (Designer) to prepare the drawing mark-

ups under the supervision of an Engineer or Senior Engineer.

Richard identified the reviewers of the MOD as:

- Julian Delgado (WSMR)
- Dan Ellis (Ft. Worth COE)
- Tony Battaglia, (Mobile COE)

Richard requested that copies of correspondence between EMC and Julian be sent to Tony and himself. It was suggested that we use the terms "planning documents" or "planning concepts" rather than "design" in our submittal language, since our work is not a preliminary design.

The proposed amount was accepted.

Richard said we should expect the Modification in one week.

Paul J. Kauffman

Action Required:
Copies to: Don Davenport
Paul Kauffman
File

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it wil be assumed that the decisions and conclusions, and status outlined in this confirmation notice is incorrect.

APPENDIX B

PROGRAM DOCUMENTATION SUPPORT DATA

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA			2. DATE 3 AUG 93
3. INSTALLATION AND LOCATION White Sands Missile Range, New Mexico			4. PROJECT TITLE ECIP HVAC / Lighting Upgrade - Building P-300	
5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NO.	8. PROJECT COST ($000) 650	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Primary Facility:				
a. Convert 7 air handling units (AHUs) and air distribution systems to variable air volume (VAV).	LS			524
b. Replace one air-cooled chiller with a water-cooled chiller.				
c. Install a 1,000 ton-hour chilled water thermal storage system.				
d. Replace standard fluorescent lamps and ballasts with reduced-wattage fluorescent lamps and ballasts.				
Supporting Facilities:				
Design Cost (6%)	LS			31
Estimated Contract Cost				555
Contingency (10%)	LS			56
Subtotal				611
Supervision, Inspection and Overhead (5.5%)	LS			34
Category E Equipment				0
TOTAL REQUEST				645
TOTAL REQUEST (ROUNDED)				650

10. DESCRIPTION OF PROPOSED CONSTRUCTION

The proposed construction on building P-300 at the White Sand Missile Range consists of the following:

- Convert four single zone and three dual-duct air handling units to VAV systems by installing variable air volume mixing boxes and variable frequency drives. Perform all necessary mechanical, electrical, and support work;
- Replace a 100 ton air-cooled chiller with a new 100 ton water-cooled chiller. Connect the new chiller to an existing cooling tower. Perform all necessary mechanical, electrical, and support work;
- Install a 1,000 ton-hour chilled water thermal storage system and perform all mechanical, electrical and support work to integrate the thermal storage system into the existing chilled water system;
- Replace 2,545 standard 4 ft. fluorescent lamps with reduced-wattage fluorescent lamps; replace 1,263 standard fluorescent ballasts with reduced-wattage ballasts.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93

3. INSTALLATION AND LOCATION
White Sands Missile Range, New Mexico

4. PROJECT TITLE ECIP HVAC / Lighting Upgrade - Building P-300	5. PROJECT NUMBER

11. REQUIREMENT

PROJECT:

Conversion of the existing single zone AHUs, dual-duct AHUs, and ductwork from constant volume air systems to variable air volume systems; the replacement of a 100 ton air-cooled chiller with a water-cooled chiller; installation of a 1,000 ton-hour chilled water thermal storage system; and the replacement of standard fluorescent lamps and ballasts with reduced-wattage lamps and ballasts. Reference Drawing Nos. M-1 through M-12 for locations and details regarding the conversion of 7 air handling units and air distribution systems to variable air volume. Reference Drawing No. M-13 for the piping schematics regarding the installation of a 100 ton water-cooled chiller and a 1,000 ton-hour chilled water thermal storage system.

REQUIREMENT:

This project is required to reduce the natural gas and electrical consumption of the air handlers by reducing the air flow rates through variable volume air flow technology. This project is also required to reduce building electrical energy consumption of the lighting and air conditioning chillers by installing new equipment with improved efficiency. This project is also required to reduce the WSMR electrical demand charges via the installation of a chilled water thermal storage system to shift the chilled water equipment load to the off peak period.

CURRENT SITUATION:

The air system in building P-300 was designed to handle high equipment heat gains in mission activity spaces. Over the years, most of the original mission equipment has been replaced with reduced wattage equipment. There have been no adjustments to fan supply air rates, although the supply air flow rates to various spaces have been adjusted many times. Most office areas are supplied by both the dual-duct AHUs and the single-zone AHUs via underfloor plenums. Overcooling occurs in these office areas due to control problems.

Building P-300 is served by 8 chillers. The 8 chillers are connected to a chilled water loop that serves the entire building, and operate 24 hours per day. This adds to the Main Post peak electrical demand. The main portion of the building is equipped with one 165 ton and one 200 ton electric centrifugal chiller, each served by a cooling tower. Six air-cooled chillers are located outside between the east and west additions. The normal sequence of chiller use is one of the two centrifugal units plus a single 50-ton air-cooled chiller, augmented by one of two 100-ton air-cooled chillers as necessary. The existing 200 ton centrifugal chiller is 10 years old and has approximately 13 years of remaining life. The existing 165 ton centrifugal chiller is original building equipment, and is used occasionally in place of the 200-ton chiller. The cooling load varies from a low of approximately 44 tons in winter to a summer high of 210 tons. Seldom are more than two chillers required to meet the load.

Building P-300 is equipped with a mixture of standard fluorescent lamps and ballasts and reduced-wattage lamps and ballasts.

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93

3. INSTALLATION AND LOCATION
White Sands Missile Range, New Mexico

4. PROJECT TITLE ECIP HVAC / Lighting Upgrade - Building P-300	5. PROJECT NUMBER

IMPACT IF NOT PROVIDED:

If this project is not funded, a reduction of 5,488 MBtu/yr cannot be achieved. Excessive amounts of natural gas and electricity will continue to be used, and there will be no contribution to energy reduction goals established for U.S. Army facilities by Army Headquarters.

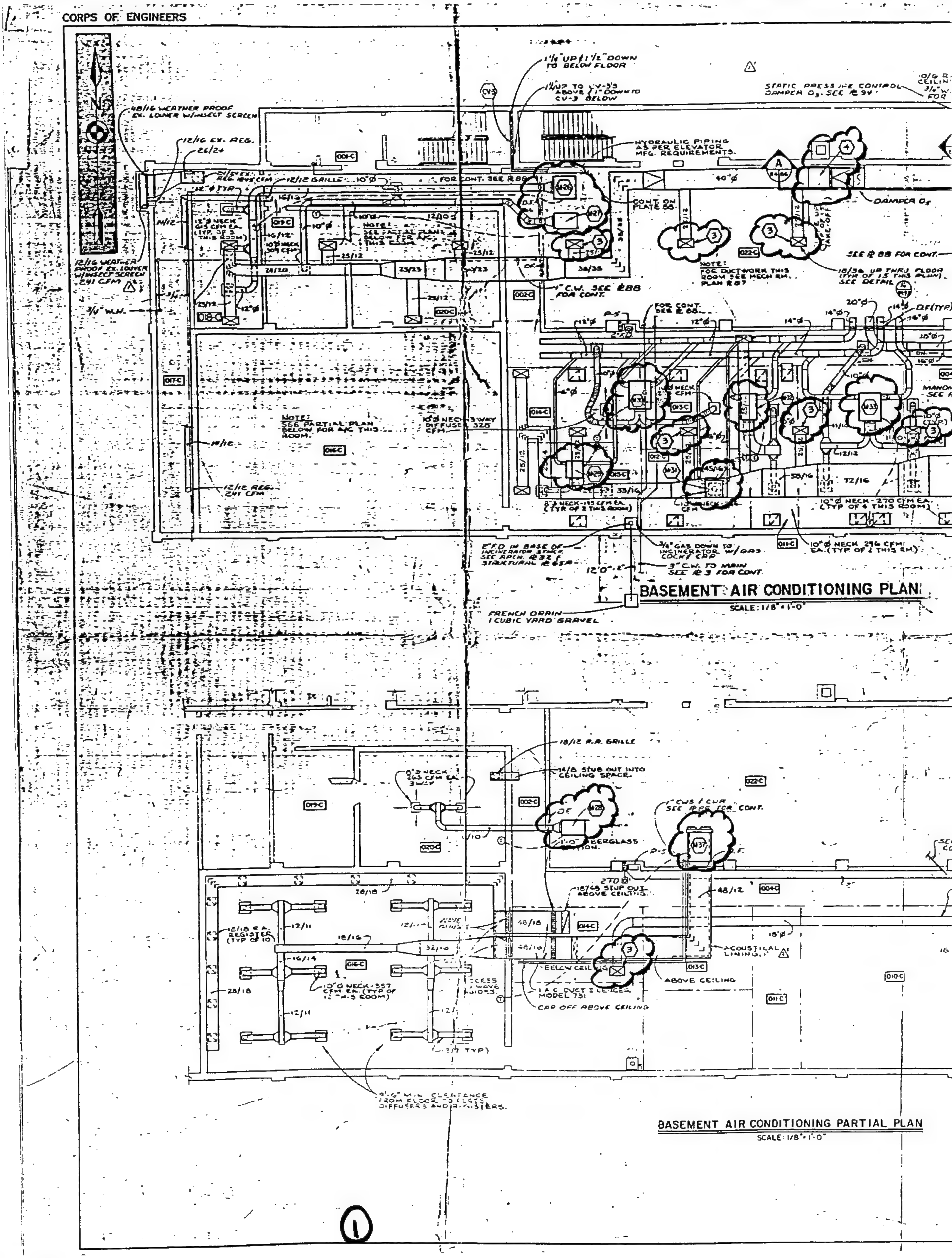
ADDITIONAL:

This project complies with the scope and design criteria of CEHSC-FU-M "Energy Conservation Investment Program (ECIP) Guidance," that were in effect 13 November 1992. The project has a Savings to Investment Ratio (SIR) of 2.3, a simple payback of 5.9 years, and an Adjusted Internal Rate of Return of 8.51%. The implementation of this project will provide an annual energy savings of 5,488 MBTU and an annual total dollar savings of $104,325.

Project validation will be through the use of electric meters on the existing UPS system to record electric consumption at Building P-300.

ESTIMATED CONSTRUCTION START:	OCT 1996	INDEX: 1999
ESTIMATED MIDPOINT OF CONSTRUCTION:	JAN 1997	INDEX: 2010
ESTIMATED CONSTRUCTION COMPLETION:	APR 1997	INDEX: 2016

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND LO(White Sands Missile



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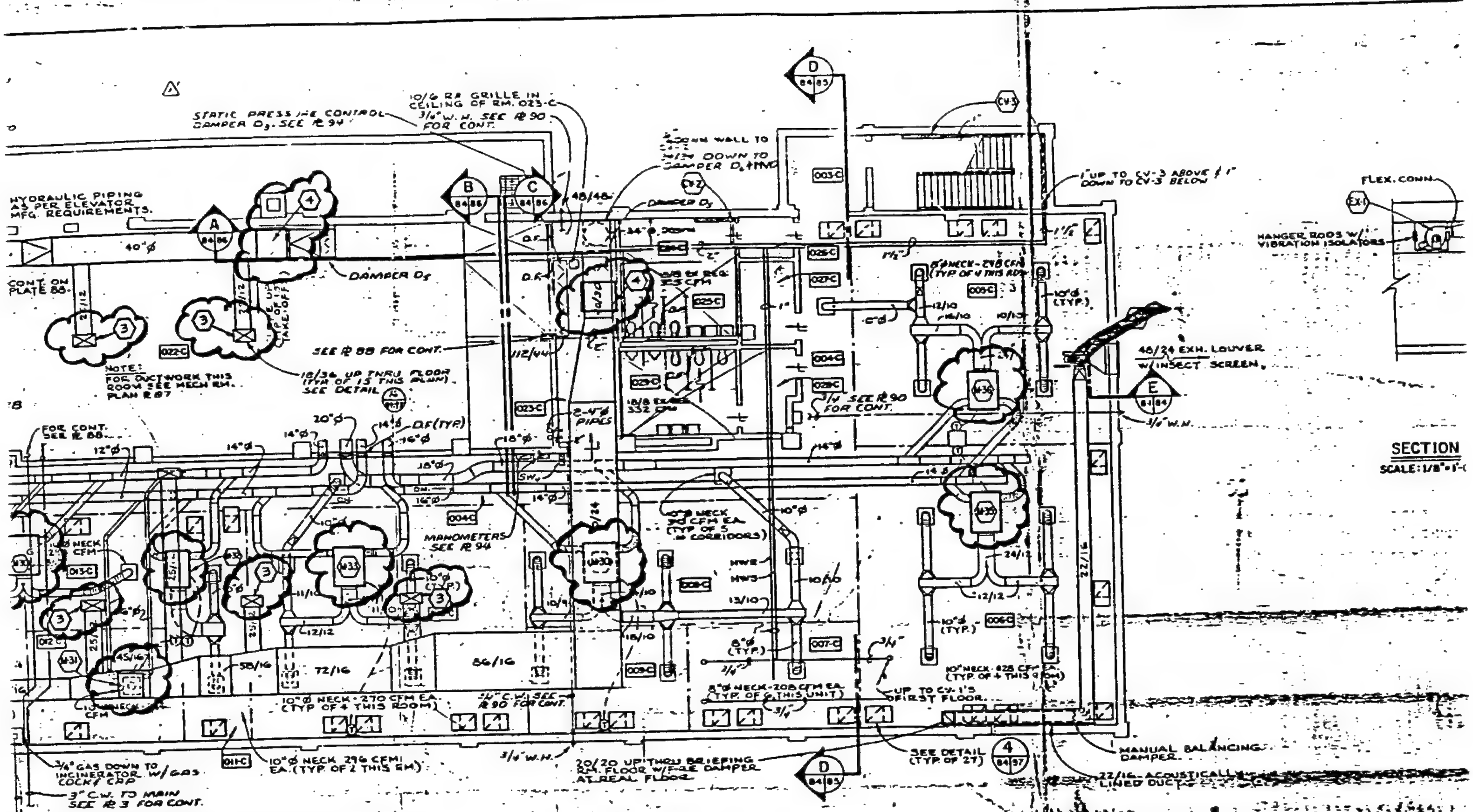
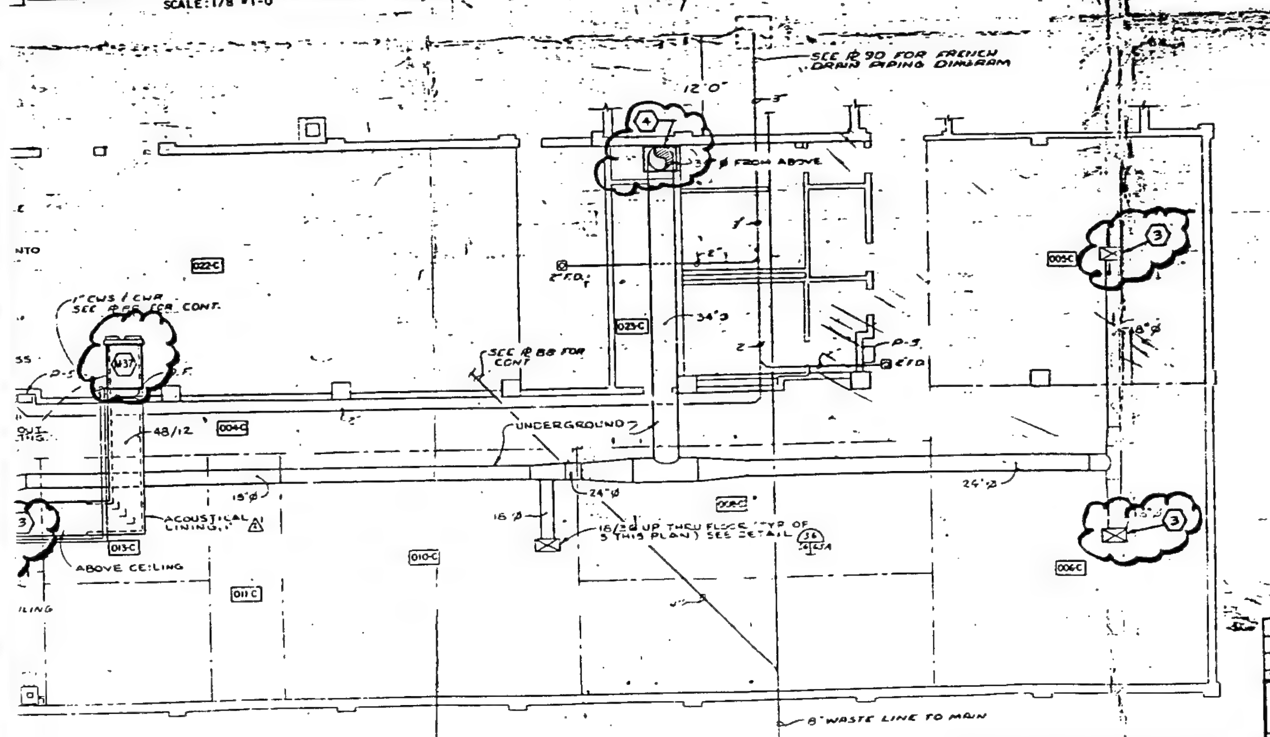
	3. INSTALLATION AND LOCATION	4. PROJECT TITLE	5.
G 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldg. 300	



BASEMENT AIR CONDITIONING PLAN

SCALE: 1/8" = 1'-0"



BASEMENT AIR CONDITIONING PARTIAL PLAN

SCALE: 1/8" = 1'-0"

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF TH
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV B
   - CAPPING OF THE SINGLE ZONE AIR SYSTEM DUCTWORK TO OFFICE ARE
   - VAV TERMINAL UNITS TO BE INSER THE SINGLE ZONE AIR SYSTEM DUC
2. DRAWING NOTES AND LOCATIONS OF WO ECIP PROJECT ARE INDICATED BY HEAV

(3) PROVIDE CAP FOR EXISTING DUCTWORK

(4) PROVIDE VAV TERMINAL UNIT IN EXISTIN AIR SYSTEM DUCTWORK

5. DETAILS PER DRAWING M-11 APPLY TO DUAL-DUCT MIXING BOX LOCATIONS.
6. DETAILS PER DRAWING M-12 APPLY TO TERMINAL UNIT LOCATIONS.

GRAPHIC SCALES

PLANNING DOC

E M C ENGINEERS INC. 2750 S WADSWORTH DENVER, COLORADO DENVER ATLANTA

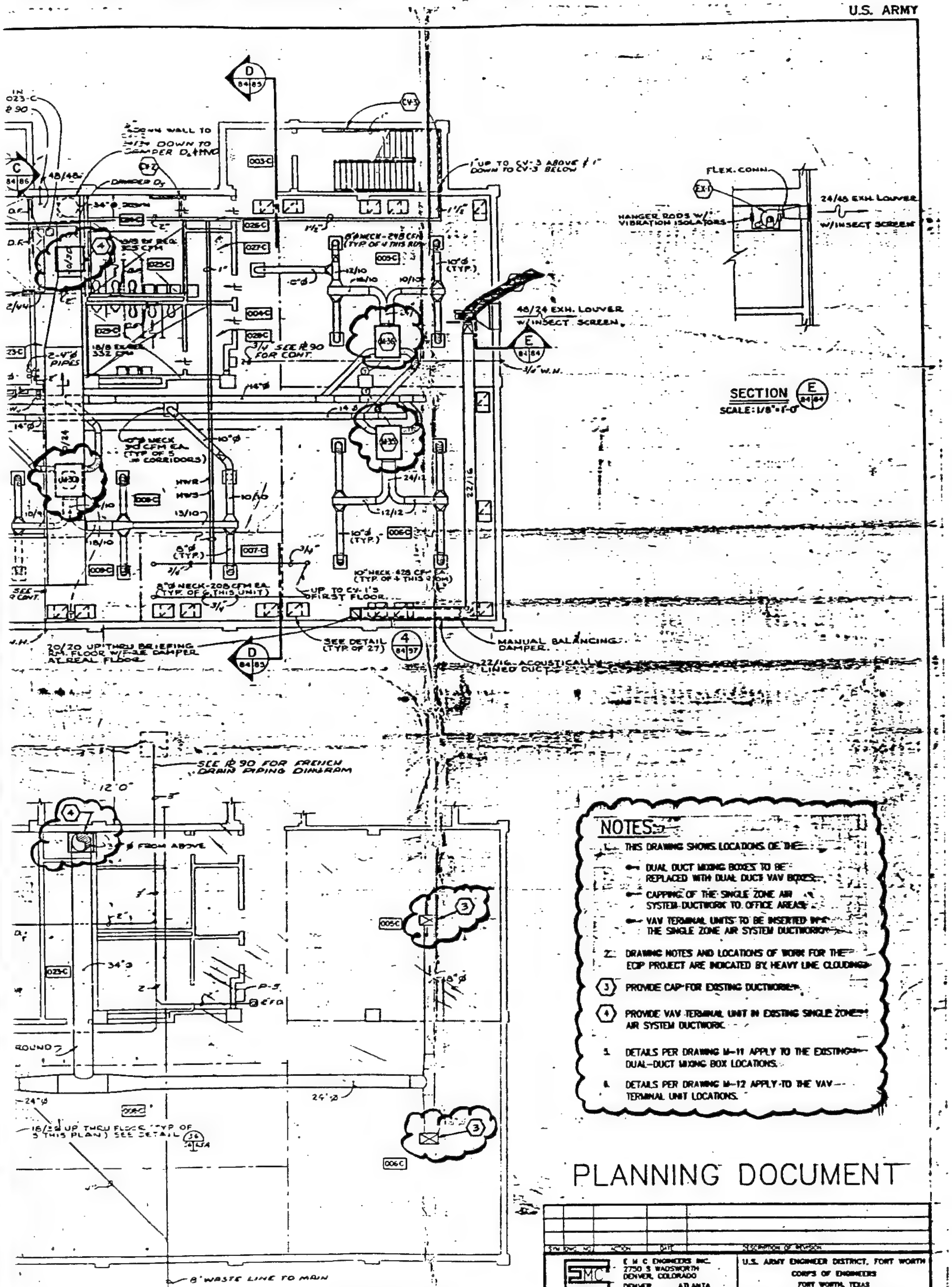
U.S. ARMY

DESIGNED BY: C.H.B.	WHITE SANDS MISSILE RA
DRAWN BY: M.D.C.	ECIP HVAC/LIGHTING UPG RANGE CONTROL CENTE
REVIEWED BY: D.L.D.	VAV RETR HVAC BASEME
SUBMITTED BY: A.J.N.	SOL. NO. / CONTR. NO. / DRAWING NUMBER M-1
ENGINEER:	

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATION.

...ON	4. PROJECT TITLE	5. PROJECT NUMBER
...nge, NM	ECIP HVAC/Lighting Upgrade – Bldg. 300	

U.S. ARMY



NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE:
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - CAPPING OF THE SINGLE ZONE AIR SYSTEM DUCTWORK TO OFFICE AREAS.
   - VAV TERMINAL UNITS TO BE INSERTED INTO THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. PROVIDE CAP FOR EXISTING DUCTWORK.
4. PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.
5. DETAILS PER DRAWING M-11 APPLY TO THE EXISTING DUAL-DUCT MIXING BOX LOCATIONS.
6. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

PLANNING DOCUMENT

SYM	DWG. NO.	ACTION	DATE	DESCRIPTION OF REVISION

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: C.H.B.
DRAWN BY: M.O.C.
REVIEWED BY: D.L.D.

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER MAIN BUILDING
VAV RETROFIT
HVAC BASEMENT PLAN

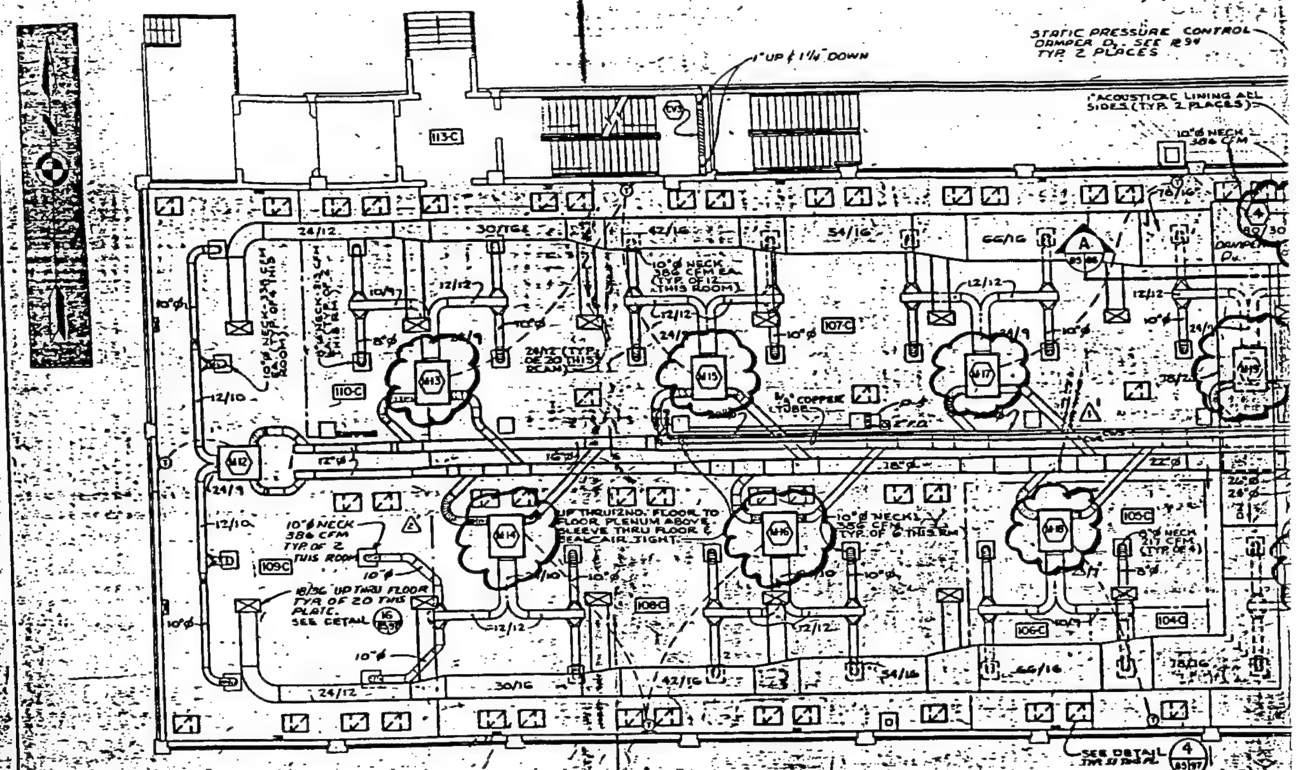
SUBMITTED BY: A.J.N.
ENGINEER:
SOL. NO.
DATED: 6-1-93
CONTR. NO.
DRAWING NUMBER: M-1
SHEET NO. 1 OF 13
SEQUENCE NO. 1

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

3

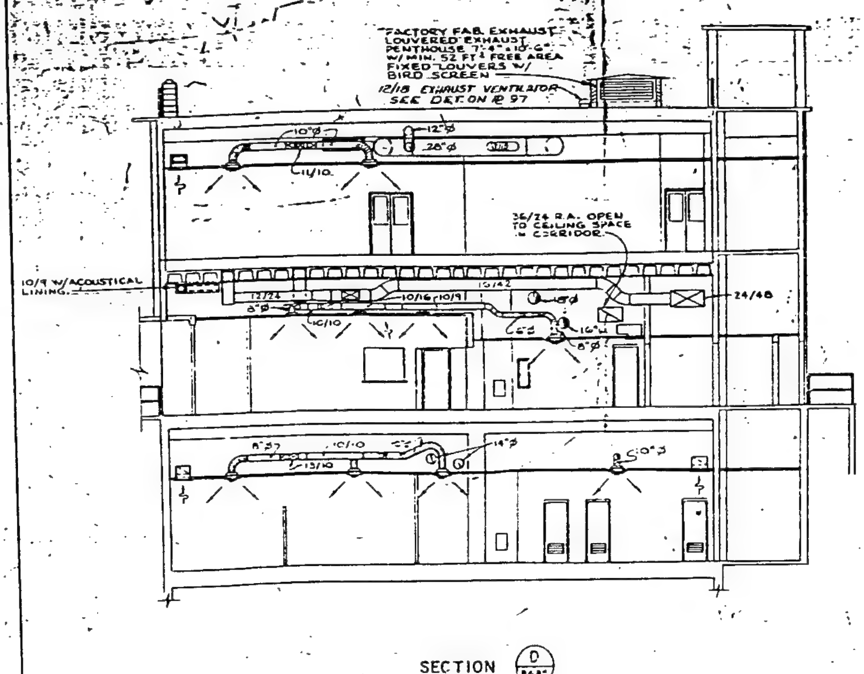
1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Mis

CORPS OF ENGINEERS



FIRST FLOOR AIR CONDITIONING PL

SCALE: 1/8"=1'-0"

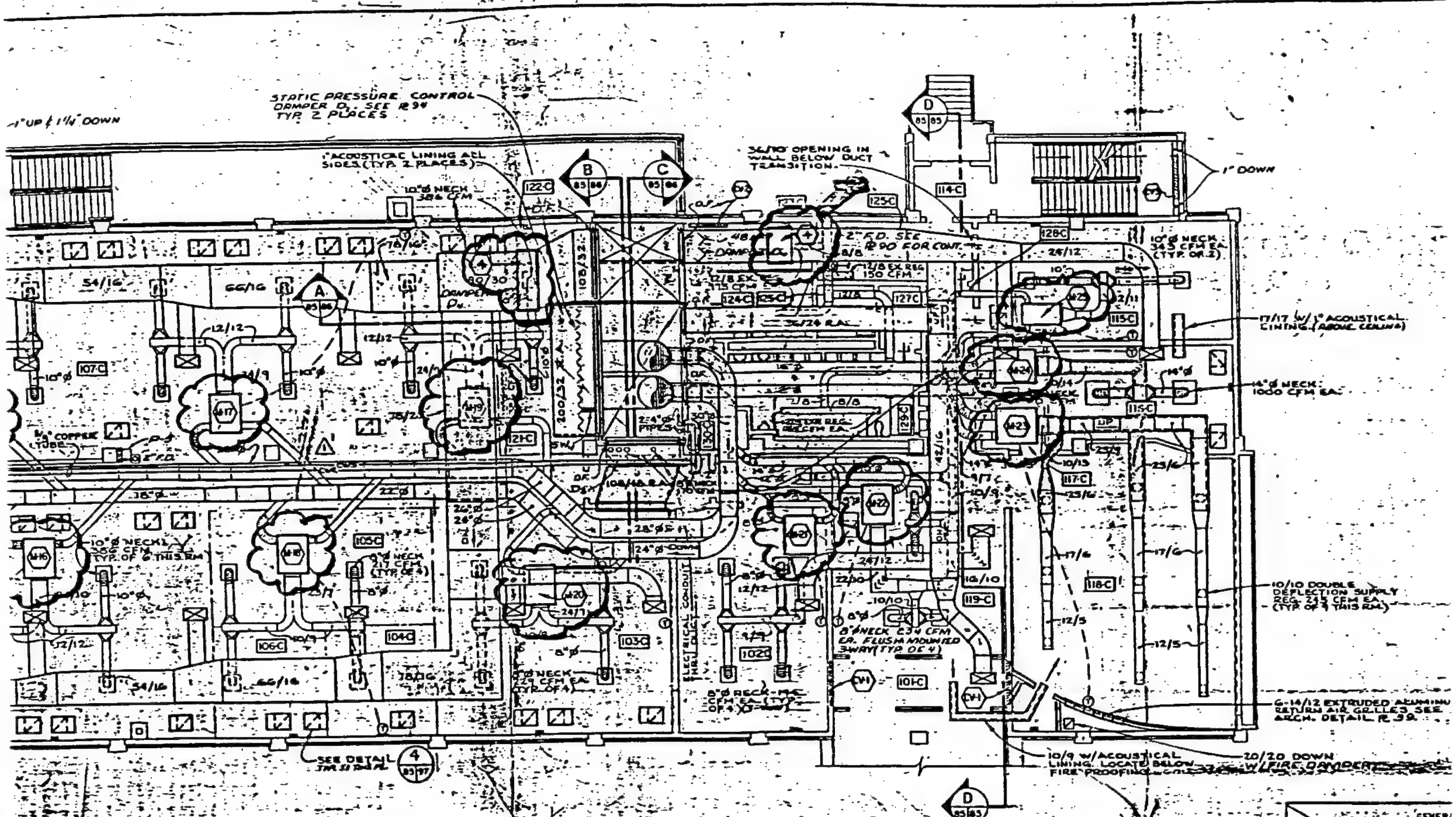


SECTION

SCALE: 1/8"=1'-0"

1

2. DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
3 AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldg.



FIRST FLOOR AIR CONDITIONING PLAN

SCALE: 1/8"=1'-0"

GENERAL NOTES

1. ROUND DUCTS FROM M-23 ... HAVE ACOUSTICAL LINING
2. SEE BRANCH DUCT TAKE-OF...
3. SEE SPLITTER DAMPER DE...
4. SEE MECHANICAL EQUIPME...
5. SEE PLATE 94 FOR A/C C...
6. ALL DUCT SIZES ARE INS...

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE:
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.
4. PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.
5. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

PLANNIN

GRAPHIC SCALES

1/8"=1'-0"

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

SYM	DESCRIPTION	ACTION	DATE

E M C ENGINEERS
2750 S WADSWORT
DENVER, COLORAD
DENVER ATL

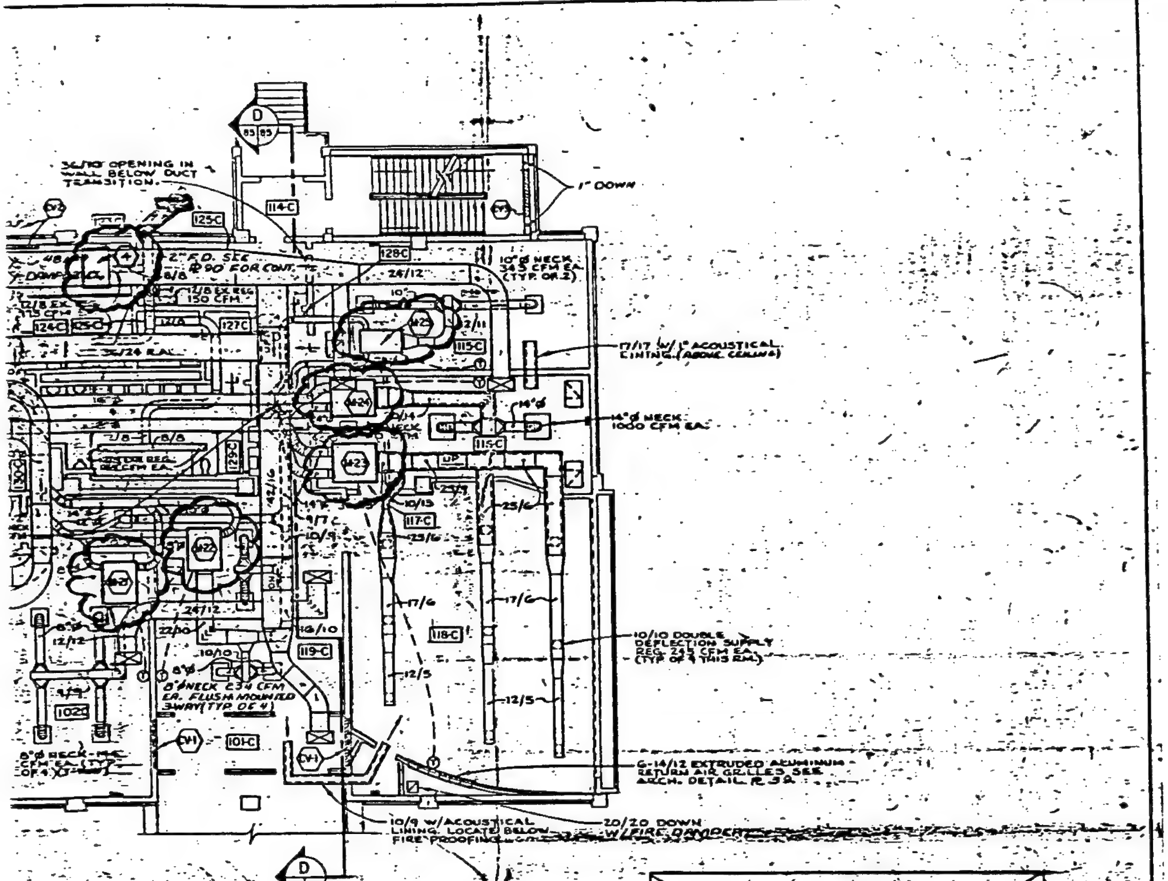
DESIGNED BY: C.H.B.	WHITE SA
DRAWN BY: M.D.C.	ECIP HVAC RANGE
REVIEWED BY: D.L.D.	HV
SUBMITTED BY: A.J.N.	
ENGINEER:	

2

DRAWING OF WORK AS BUILT

4. PROJECT TITLE	5. PROJECT NUMBER
NM ECIP HVAC/Lighting Upgrade – Bldg. 300	

U.S. ARMY



GENERAL NOTES-

1. ROUND DUCTS FROM M-23 & M-24 TO 36/9 & 18/8 MAINS TO HAVE ACOUSTICAL LINING.
2. SEE BRANCH DUCT TAKE-OFF DETAIL 7
3. SEE SPLITTER DAMPER DETAIL 5
4. SEE MECHANICAL EQUIPMENT SCHEDULE PLATE 96.
5. SEE PLATE 94 FOR A/C CONTROLS.
6. ALL DUCT SIZES ARE INSIDE DIMENSIONS.

TES

THIS DRAWING SHOWS LOCATIONS OF THE

- DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
- VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.

DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.

DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.

PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.

DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

PLANNING DOCUMENT

GRAPHIC SCALES

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

(3)

SYM	DWG. NO.	ACTION	DATE	DESCRIPTION OF REVISION

EMC — E M C ENGINEERS INC. 2750 S WADSWORTH DENVER, COLORADO. DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER MAIN BUILDING

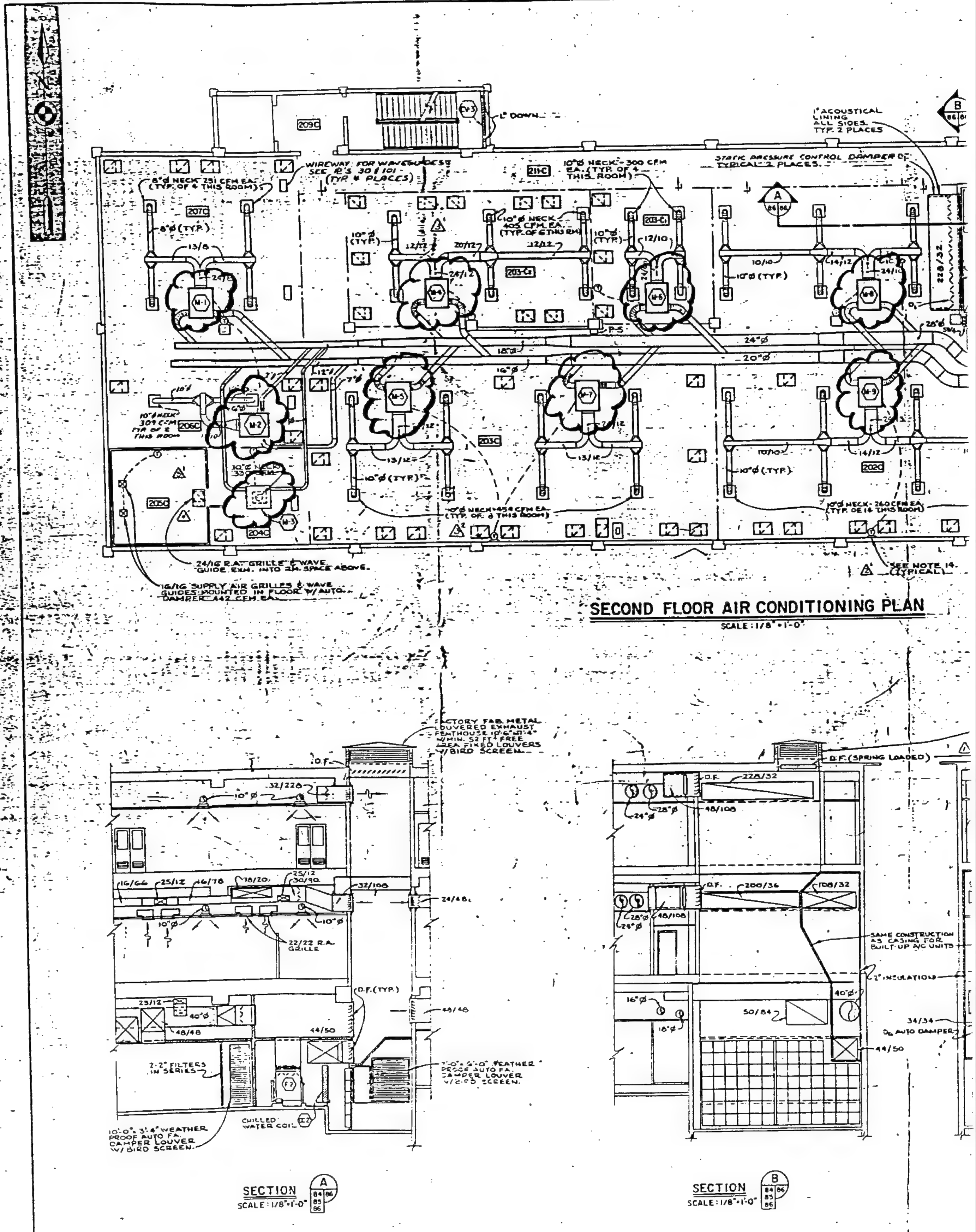
VAV RETROFIT
HVAC FIRST FLOOR PLAN

SUBMITTED BY: A.J.N.
ENGINEER:
SOL. NO.
DATED: 6-1-93
CONTR. NO.
DRAWING NUMBER M-2
SHEET NO. 2 OF 13
SEQUENCE NO. 2

DRAWING OF WORK AS BUILT

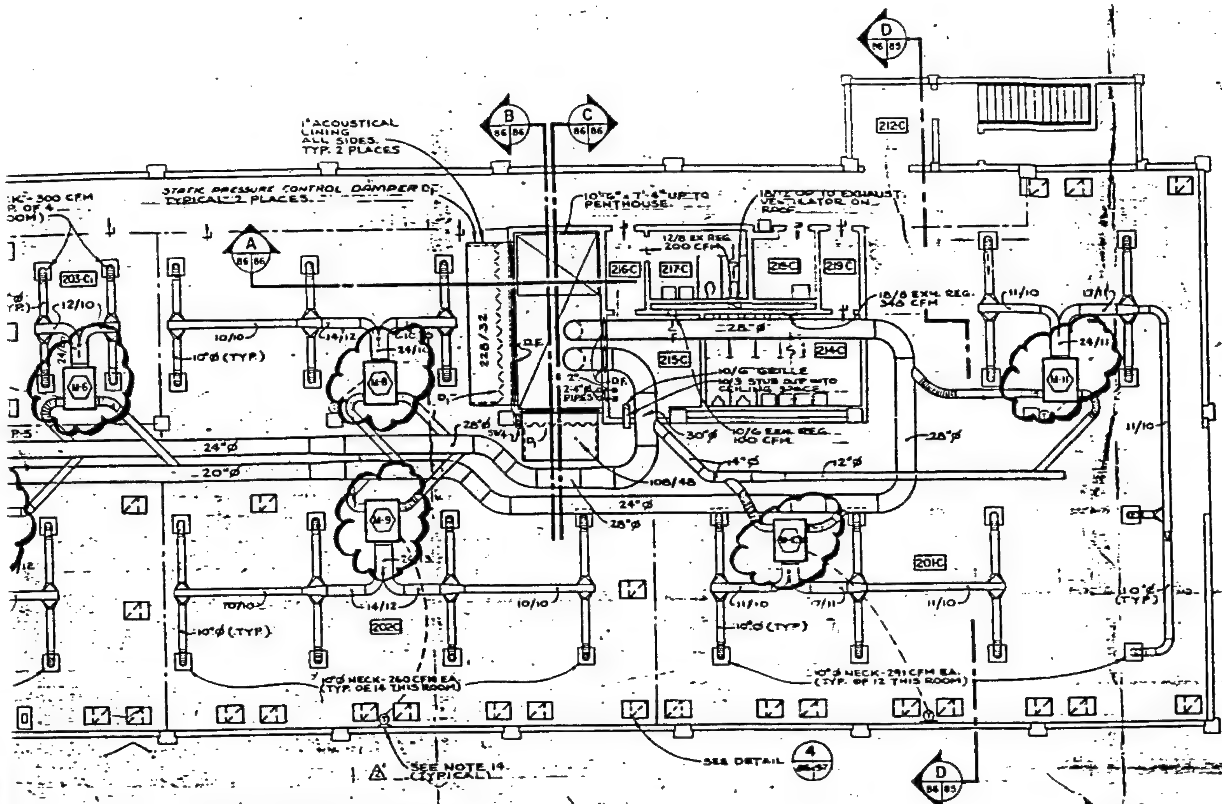
1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Miss

CORPS OF ENGINEERS



①

DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldg. 3C

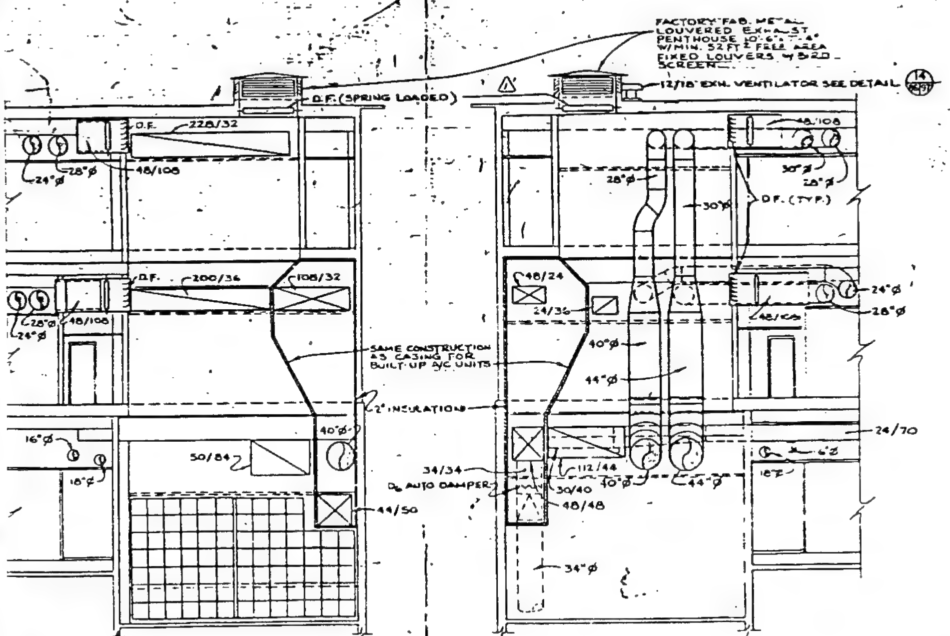


COND FLOOR AIR CONDITIONING PLAN

SCALE: 1/8" = 1'-0"

GENERAL NOTES
(TYP. ALL FLOORS THIS BLDG.)

1. CEILING DIFFUSERS SHALL BE SQUARE, FULL S (EXCEPT IN LOBBY).
2. RETURN AIR GRILLES TO BE 24" X 24" NOMINI SYSTEM AND HAVE A MINIMUM OF 2.5 SQ.FT. F
3. SEE BRANCH DUCT TAKE-OFF DETAIL
4. SEE SPLITTER DAMPER DETAIL
5. SEE MECHANICAL EQUIPMENT SCHEDULE PLATE
6. ALL PENETRATIONS THRU THE MEMBRANE COAT ETC.) SHALL BE SEALED AIRTIGHT. SEE ARCHITE LOCATIONS OF MEMBRANE COATINGS.
7. D.F. – FIRE DAMPER
8. SEE PLATE 94 FOR A/C CONTROLS.
9. ALL DUCT SIZES ARE INSIDE DIMENSIONS.
10. ROUND DUCT ELBOWS SHALL BE EITHER SMOOTH & MITERED ELBOWS SHALL NOT BE PERMITTED.
11. BOTH THE PRE AND THE ABSOLUTE FILTERS SH MANUFACTURES FRAMES COMPLETE WITH GASKET
12. REMOVE FLOOR PANELS AS REQUIRED TO TEST.
13. BRANCH DUCTS FROM DUAL DUCT MAINS TO MIX SIZE AS MIXING BOX INLETS.
14. THERMOSTATS ON OUTSIDE WALLS SHALL BE MO INSULATING BACK BOARDS.



SECTION B
SCALE: 1/8" = 1'-0"

SECTION C
SCALE: 1/8" = 1'-0"

GRAPHIC SCALES

NOTES:
1. THIS DRAWING SHOWS LOCATIONS OF TH
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BO
2. DRAWING NOTES AND LOCATIONS OF WO ECIP PROJECT ARE INDICATED BY HEAV
3. DETAILS PER DRAWING M-11 APPLY TO DUAL-DUCT MIXING BOX LOCATIONS.

PLANNING DO

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. AR

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.

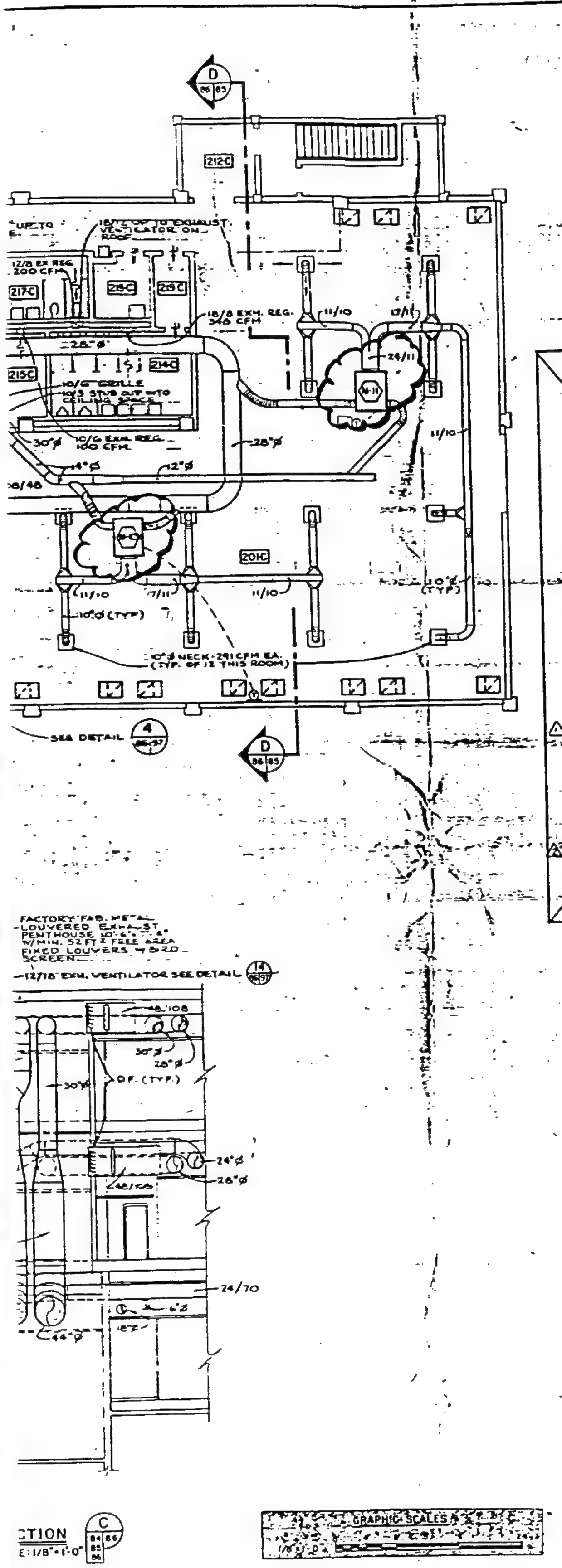
WHITE SANDS MISSILE
ECIP HVAC/LIGHTING UP
RANGE CONTROL CEN
VAV RE
HVAC SECOND

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

DRAWING OF WORK AS BUILT

...ge, NM	4. PROJECT TITLE ECIP HVAC/Lighting Upgrade – Bldg. 300	5. PROJECT NUMBER

U.S. ARMY



GENERAL NOTES

(TYP. ALL FLOORS THIS BLDG.)

1. CEILING DIFFUSERS SHALL BE SQUARE, FULL STEPPED DOWN TYPE (EXCEPT IN LOBBY).
2. RETURN AIR GRILLES TO BE 24" X 24" NOMINAL TO FIT CEILING SYSTEM AND HAVE A MINIMUM OF 2.5 SQ.FT. FREE AREA. SEE DETAIL 4
3. SEE BRANCH DUCT TAKE-OFF DETAIL 7
4. SEE SPLITTER DAMPER DETAIL 5
5. SEE MECHANICAL EQUIPMENT SCHEDULE PLATE 96.
6. ALL PENETRATIONS THRU THE MEMBRANE COATING (DUCTS, PIPING, CONDUITS, ETC.) SHALL BE SEALED AIRTIGHT. SEE ARCHITECTURAL DRAWINGS FOR LOCATIONS OF MEMBRANE COATINGS.
7. D.F. – FIRE DAMPER
8. SEE PLATE 94 FOR A/C CONTROLS
9. ALL DUCT SIZES ARE INSIDE DIMENSIONS.
10. ROUND DUCT ELBOWS SHALL BE EITHER SMOOTH OR FIVE PIECE. THREE PIECE & MITERED ELBOWS SHALL NOT BE PERMITTED.
11. BOTH THE PRE AND THE ABSOLUTE FILTERS SHALL BE MOUNTED IN STANDARD MANUFACTURES FRAMES COMPLETE WITH GASKETS AND RETAINING BRACKETS.
12. REMOVE FLOOR PANELS AS REQUIRED TO TEST SYSTEM.
13. BRANCH DUCTS FROM DUAL DUCT MAINS TO MIXING BOXES SHALL BE SAME SIZE AS MIXING BOX INLETS.
14. THERMOSTATS ON OUTSIDE WALLS SHALL BE MOUNTED ON 1"x18"x18" INSULATING BACK BOARDS.

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.

PLANNING DOCUMENT

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

3

SYM	DWG. NO.	ACTION	DATE	DESCRIPTION OF REVISION

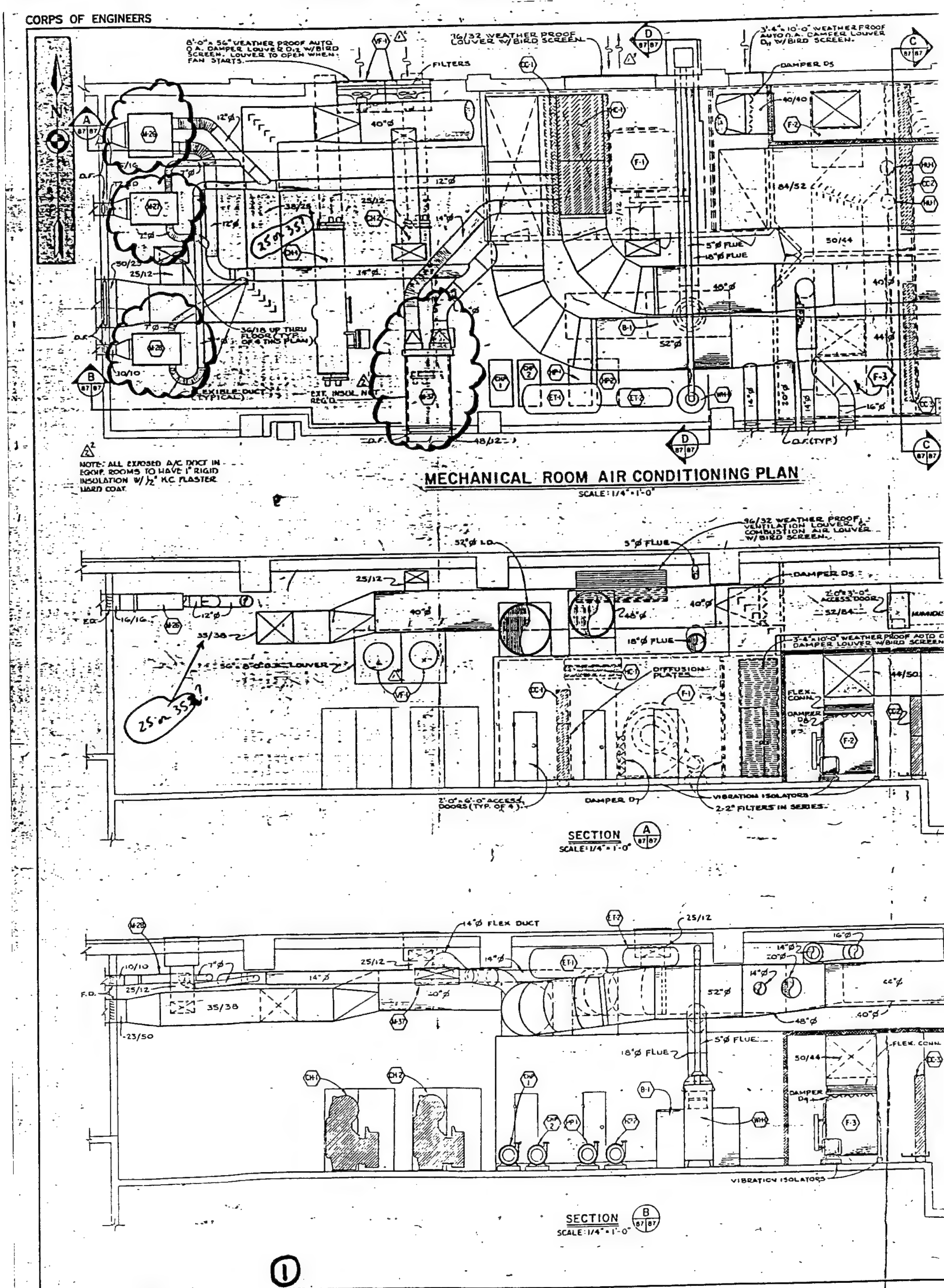
E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

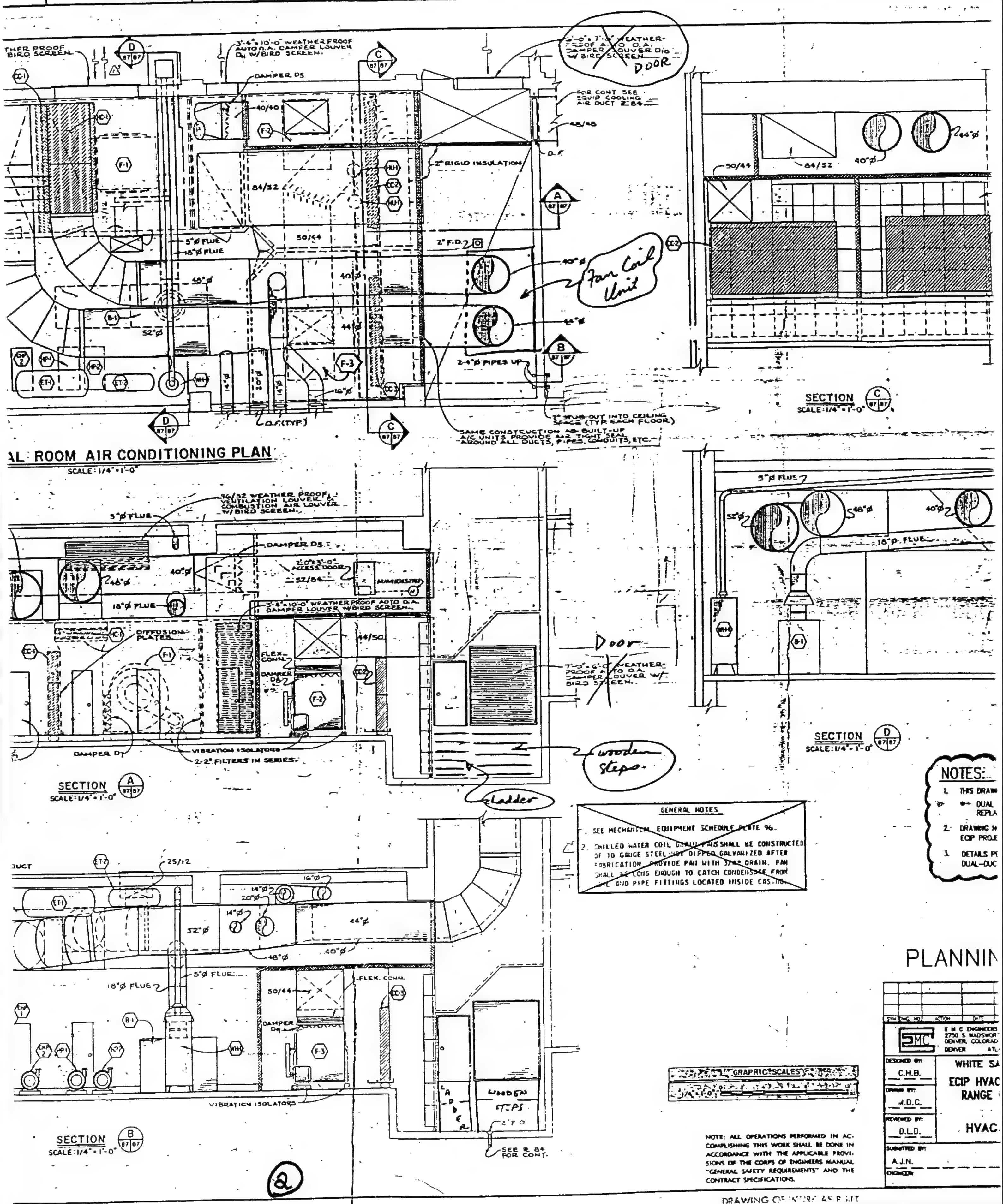
DESIGNED BY: C.H.B.	WHITE SANDS MISSILE RANGE, NEW MEXICO
DRAWN BY: M.D.C.	ECIP HVAC/LIGHTING UPGRADE–BUILDING 300 RANGE CONTROL CENTER MAIN BUILDING
REVIEWED BY: D.L.D.	VAV RETROFIT HVAC SECOND-FLOOR PLAN
SUBMITTED BY: A.J.N.	SOL. NO. / DATED: 6-1-93
ENGINEER:	CONTR. NO.
	DRAWING NUMBER M-3 / SHEET NO. 3 of 13 / SEQUENCE NO. 3

DRAWING OF WORK AS BUILT

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND
			White Sands Miss

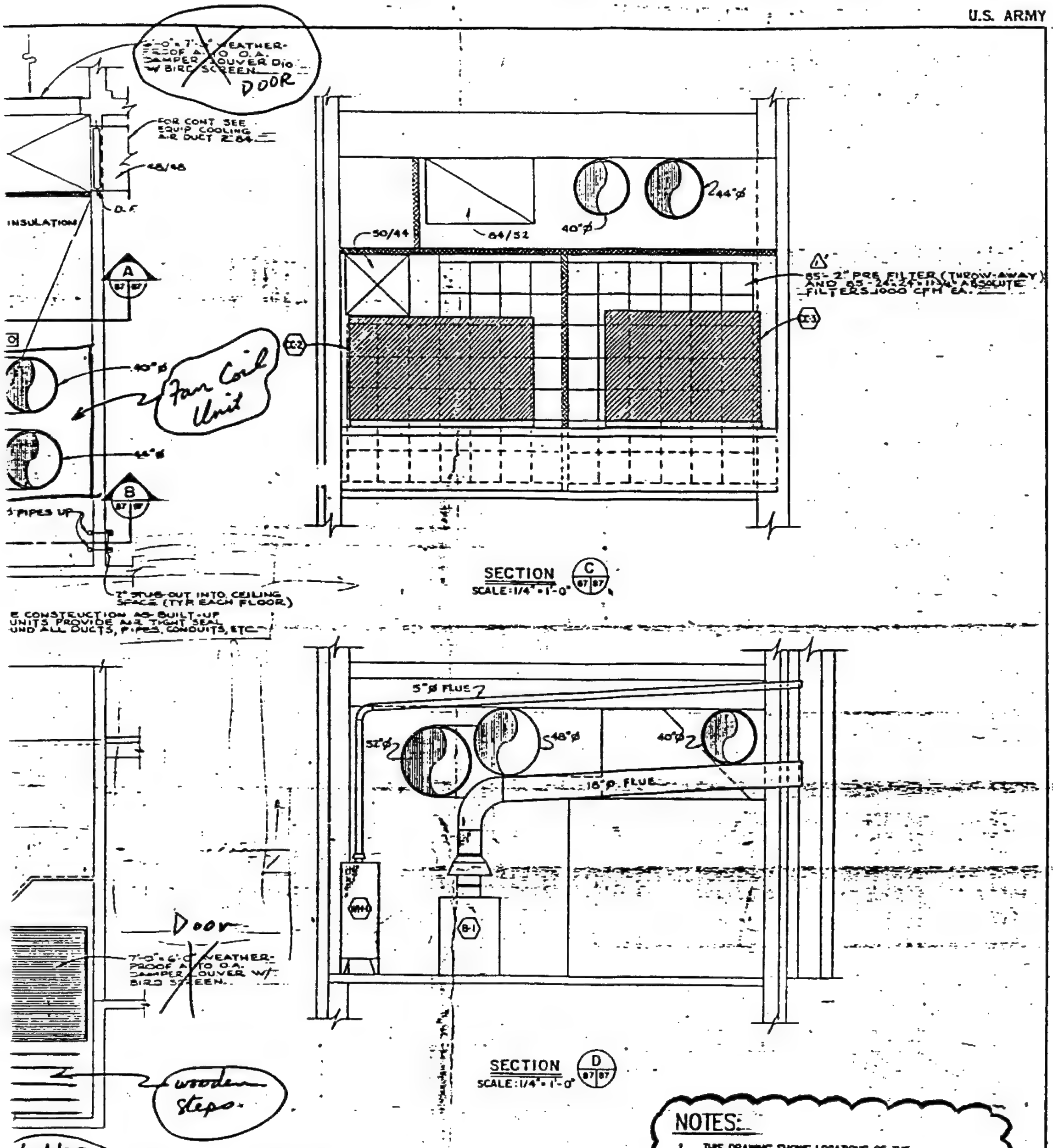


ON	2. DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
	3 AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bl



N	4. PROJECT TITLE	5. PROJECT NUMBER
nge, NM	ECIP HVAC/Lighting Upgrade – Bldg. 300	

U.S. ARMY



NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.

GENERAL NOTES

1. SEE MECHANICAL EQUIPMENT SCHEDULE PLATE 96.
2. CHILLED WATER COIL DRAIN PANS SHALL BE CONSTRUCTED OF 10 GAUGE STEEL HOT DIPPED GALVANIZED AFTER FABRICATION. PROVIDE PAN WITH 3/4" DRAIN. PAN SHALL BE LONG ENOUGH TO CATCH CONDENSATE FROM VALVE AND PIPE FITTINGS LOCATED INSIDE CASING.

GRAPHIC SCALES

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

3

PLANNING DOCUMENT

SYM	DWG. NO.	ACTION	DATE	DESCRIPTION OF REVISION

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.
ENGINEER:

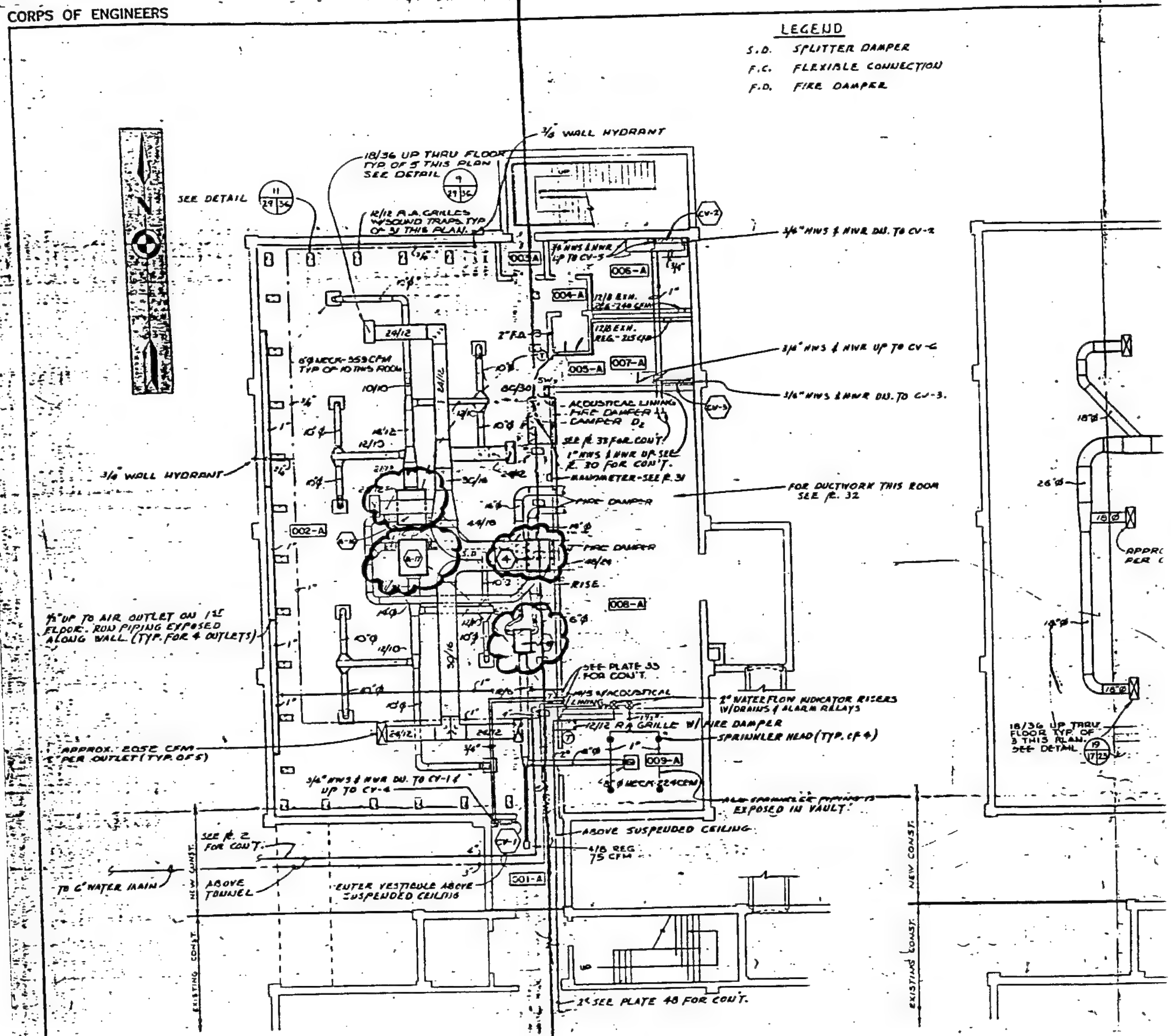
WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER MAIN BUILDING
VAV RETROFIT
HVAC. MECHANICAL ROOM PLAN

SOL. NO.
DATED: 6-1-93
CONTR. NO.
DRAWING NUMBER: M-4
SHEET NO. 4 OF 13
SEQUENCE NO. 4

DRAWING OF WORK AS BUILT

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Miss

CORPS OF ENGINEERS



BASEMENT AIR CONDITIONING PLAN

SCALE: 1/8" = 1'-0"

BASEMENT AIR CO

NOTES:

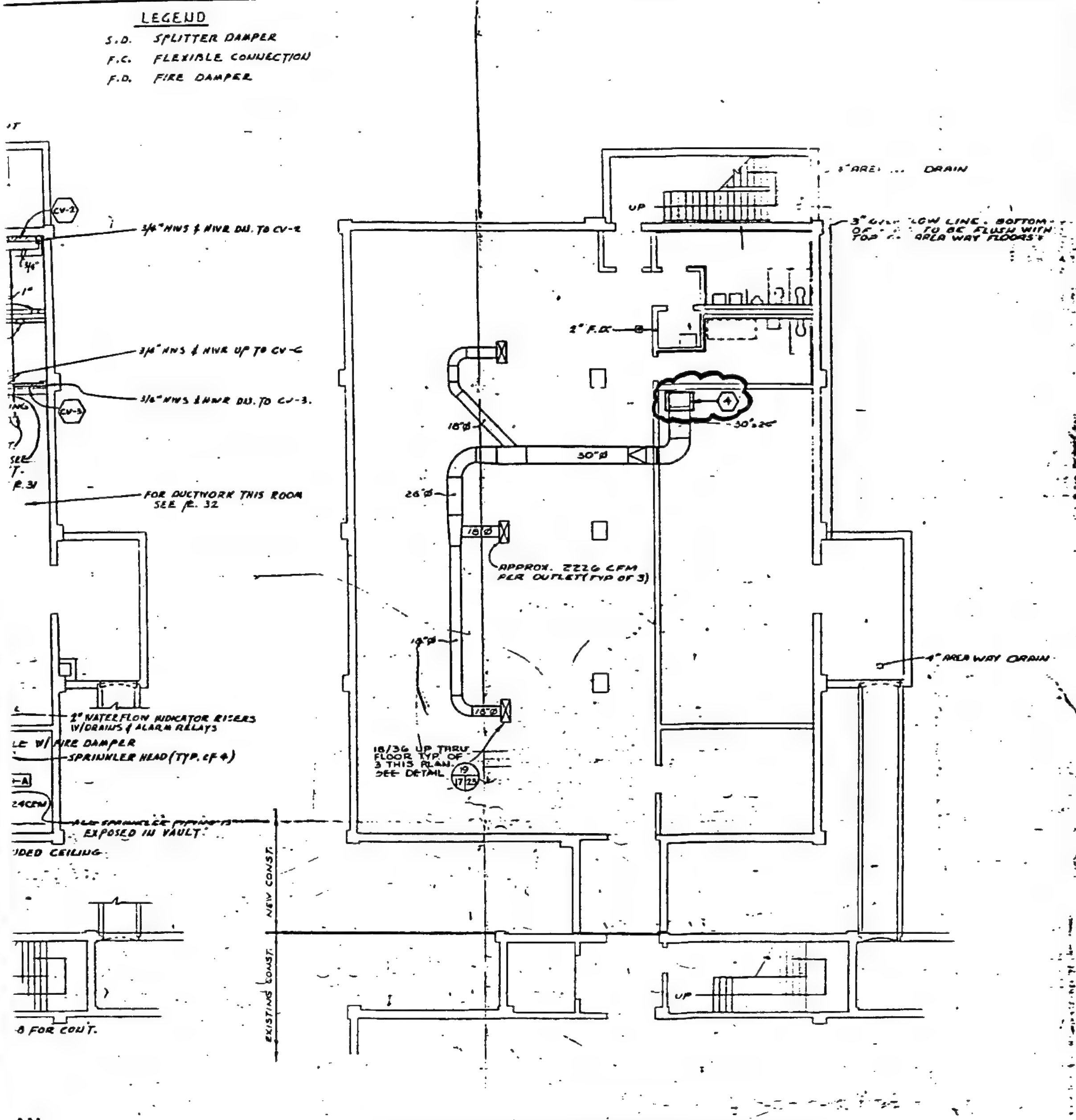
1. THIS DRAWING SHOWS LOCATIONS OF THE
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.

(4) PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.

5. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

1

2. DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
3 AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldc



BASEMENT AIR CONDITIONING PLAN – UNDERGROUND
SCALE: 1/8"=1'-0"

MECHANICAL EQUIPME

NOTE: ALL QUANTITIES GIVEN IN THE EQUIPMENT SCHEDULE ARE FOR

SYMBOL	DESCRIPTIO
B-1	BOILER – NATURAL GAS FIRED PACKAGED HOT WATER STEEL, SBI OR AGA RATED. ORIFICED FOR 4,000 FT. OPERATION.
CH-1 AND CH-2	CHILLER – PACKAGED AIR COOLED TYPE COMPLETE W/ COMPRESSOR(S), INSULATED DIRECT EXPANS COOLED CONDENSER, AND COMPLETE OPERAT HAVE THE CAPACITY SHOWN WHILE OPERATI GLYCOL BY WEIGHT, 100°FDB AMBIENT AIR SHALL BE PROVIDED WITH HEATING CABLE THE EVAPORATOR AND PIPING FROM FREEZI 60 CYCLE MOTORS.

SYMBOL	EVAPORATOR – ETHYLENE GLYCOL SOLUTION – ENT	LVE	GPM	MAX. P.D.
CH-1	54°F	45°F	102	16 FT
CH-2	54°F	45°F	102	16 FT

AZ-1 — COMFORT AIR CONDITIONING UNIT – PACKAGED MULT HOT WATER COIL, CHILLED WATER COIL, 440 VOLT, 3 PHASE, 60 CYCLE MOTOR.

FAN CAPACITY	TOTAL STATIC PRESSURE	APP
16,232 CFM	4.64 INCHES W.G.	

COOLING COIL CAPACITY	CFM	ENT. AIR TEMP.	LV. AIR TEMP.
476,233 BTUH BTH	16232	84.1°FDB 63.4°FWB	55°FDB 53.7°FWB

HEATING COIL CAPACITY	CFM	ENT. AIR TEMP.	LV. AIR TEMP.
420,306 BTUH	8697	63°F	120°F

*COOLANT IS A SOLUTION OF 75% WATER AND

ATOMIZING SPRAY HUMIDIFIER – UNIT TO PRODUCE

AC-1 — EQUIPMENT AIR CONDITIONING UNIT – PACKAGED SPRA PUMP, FAN AND MOTOR. 440 VOLT, 3 PH

COOLING COIL CAP.	CFM	ENT. AIR TEMP.	LV. AIR TEMP.
489,046 BTUH(SEN.)	22224	75.37°FDB 60.6°FWB	52.1°FDB 51°FWB

FAN CAPACITY	TOTAL STATIC PRESSURE	APP
22,224 CFM	4.03 INCHES W.G.	

* COOLANT IS A SOLUTION OF 75% WATER 25%

EC-1 — EVAPORATIVE COOLER-SIDE DISCHARGE TYPE AND RECIRCULATING PUMP- 7000 APPROX. 3/4 H.P., 208V, 3 PHASE PUMP APPROX. 1 1/2 AMPS, 115

WH-1 — HOT WATER HEATER-STORAGE TYPE, AGA RATED, ORIFI LEVEL INPUT, 42 GAL. SEA LEVEL RECOV NATURAL GAS FUEL.

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.
4. PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.
5. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

~~GENERAL NOTES~~

1. ~~SEE SPLITTER DAMPER DETAIL~~ 2 / 29|32
2. ~~SEE CONVECTOR PIPING DETAIL~~ 3 / 29|32
3. ~~SEE BRANCH DUCT TAKE-OFF DETAIL~~ 7 / 29|32
4. ~~SEE MIXING BOX DETAIL~~ 10 / 29|32
5. ~~REMOVE FLOOR PANELS AS REQUIRED TO TEST SYSTEM.~~

GRAPHIC SCALE
1/8"=1'-0"

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATION.

②

PLANNING

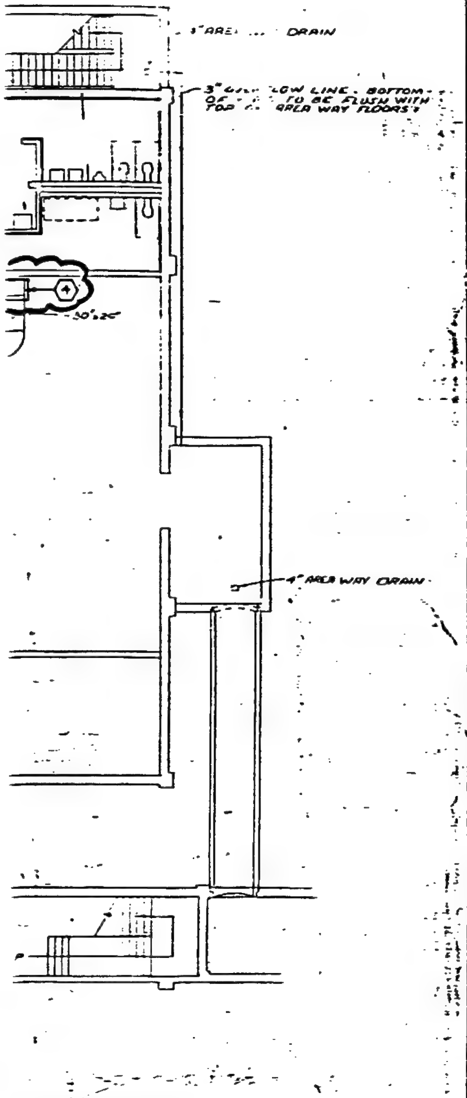
E M C ENGINEERS INC.
2750 S. WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

DESIGNED BY: C.H.B.	WHITE SANDS
DRAWN BY: M.D.C.	ECIP HVAC/LIG RANGE CONT
REVIEWED BY: D.L.D.	HVAC
SUBMITTED BY: A.J.N.	

DRAWING OF WORK: AS-BUILT

4. PROJECT TITLE	5. PROJECT NUMBER
e, NM · ECIP HVAC/Lighting Upgrade – Bldg. 300	

U.S. ARMY



MECHANICAL EQUIPMENT SCHEDULE

NOTE: ALL QUANTITIES GIVEN IN THE EQUIPMENT SCHEDULE ARE FOR 4,000 FT. ELEVATION UNLESS OTHERWISE NOTED.

SYMBOL	DESCRIPTION
B-1	BOILER – NATURAL GAS FIRED PACKAGED HOT WATER BOILER (180°F MAX. WATER TEMPERATURE). STEEL, SBI OR AGA RATED, 30 PSIG MAXIMUM OPERATING PRESSURE, ORIFICED FOR 4,000 FT. OPERATION. 865,956 BTUH OUTPUT AT SEA LEVEL.
CH-1 AND CH-2	CHILLER – PACKAGED AIR COOLED TYPE COMPLETE W/ OPEN OR HERMETICALLY SEALED RECIPROCATING COMPRESSOR(S), INSULATED DIRECT EXPANSION SHELL AND TUBE TYPE EVAPORATOR, AIR COOLED CONDENSER, AND COMPLETE OPERATING AND SAFETY CONTROLS. CHILLERS SHALL HAVE THE CAPACITY SHOWN WHILE OPERATING WITH A SOLUTION OF 75% WATER AND 25% ETHYLENE GLYCOL BY WEIGHT, 100°FDB AMBIENT AIR. THE EVAPORATOR AND CHILLED WATER PIPING SHALL BE PROVIDED WITH HEATING CABLE UNDER THE INSULATION WITH CAPACITY TO PROTECT THE EVAPORATOR AND PIPING FROM FREEZING DOWN TO 0°FDB AMBIENT. 440 VOLT, 3 PHASE, 60 CYCLE MOTORS.

SYMBOL	EVAPORATOR					AIR COOLED CONDENSER		REFRIGERANT COMPRESSORS
	ETHYLENE GLYCOL SOLUTION				COOLING LOAD BTUH			
	ENT	LVE	GPM	MAX. P.D.		APPROX. HP.	MAX. FAN T.S.	APPROX. K.W. INPUT
CH-1	54°F	45°F	102	16 FT	435080	5	7000FPM	484
CH-2	54°F	45°F	102	16 FT	435080	5	7000FPM	484

SYMBOL	DESCRIPTION
MZ-1	COMFORT AIR CONDITIONING UNIT – PACKAGED MULTI-ZONE UNIT COMPLETE WITH DOUBLE DUCT ADAPTER, HOT WATER COIL, CHILLED WATER COIL, FAN, MOTOR, AND ATOMIZING SPRAY HUMIDIFIER. 440 VOLT, 3 PHASE, 60 CYCLE MOTOR.

FAN CAPACITY	TOTAL STATIC PRESSURE	APPROX. B.P.	APPROX. RPM
16,232 CFM	4.64 INCHES W.G.	25	1345

COOLING COIL CAPACITY	CFM	ENT. AIR TEMP.	LV. AIR TEMP.	ENT. COOLANT *	LV. COOLANT *	GPM	MAX. P.D.	MAX. COIL FACE VEL	AIR P.D.
476,233 BTUH GTH	16232	84.1°FDB 63.4°FWB	55°FDB 53.7°FWB	45°F	55°F	100.3	11 FT.	500 FPM	0.42" W.G.

HEATING COIL CAPACITY	CFM	ENT. AIR TEMP.	LV. AIR TEMP.	ENT. WATER	GPM	MIN. FACE AREA	MAX. P.D.	AIR P.D.
420,206 BTUH	8497	67°F	120°F	180°F	42	14.43 FT	3 FT.	0.13" W.G.

*COOLANT IS A SOLUTION OF 75% WATER AND 25% ETHYLENE GLYCOL BY WEIGHT.

ATOMIZING SPRAY HUMIDIFIER – UNIT TO PRODUCE 100LB. OF WATER VAPOR PER HOUR.

SYMBOL	DESCRIPTION
EC-1	EQUIPMENT AIR CONDITIONING UNIT – PACKAGED SPRAYED COIL UNIT COMPLETE WITH SPRAYED COIL, PUMP, FAN AND MOTOR. 440 VOLT, 3 PHASE, 60 CYCLE MOTOR.

COOLING COIL CAP.	CFM	ENT. AIR TEMP.	LV. AIR TEMP.	ENT. COOLANT *	LV. COOLANT *	GPM	MAX. P.D.	MAX. COIL FACE VEL	AIR P.D.
489,046 BTUH(SEN.)	22224	75.57°FDB 60.6° FWB	52.1°FDB 51° FWB	45°F	55°F	103	15 FT.	500 FPM	0.92" W.G.

FAN CAPACITY	TOTAL STATIC PRESSURE	APPROX. B.P.	APPROX. RPM
22,224 CFM	4.03 INCHES W.G.	25	900

* COOLANT IS A SOLUTION OF 75% WATER 25% ETHYLENE GLYCOL BY WEIGHT.

SYMBOL	DESCRIPTION
EC-1	EVAPORATIVE COOLER – SIDE DISCHARGE TYPE COMPLETE WITH FAN, MOTOR, FLOAT VALVE AND RECIRCULATING PUMP – 7000 CFM AT 1/8" W.G. EXTERNAL STATIC PRESSURE. APPROX. ¾ H.P., 208V, 3 PHASE 60 CYCLE FAN MOTOR. RECIRCULATING PUMP APPROX. 1 1/2 AMPS, 115 VOLTS.
WH-1	HOT WATER HEATER – STORAGE TYPE, AGA RATED, ORIFICED FOR 4000 FT. OPERATION. 50,000 BTUH SEA LEVEL INPUT. 42 GAL. SEA LEVEL RECOVERY AT 100° F RISE. 50 GAL. STORAGE TANK NATURAL GAS FUEL.

1 – UNDERGROUND

GENERAL NOTES

~~SEE SPLITTER DAMPER DETAIL 2 / 29 | 36~~

~~SEE CONVECTOR PIPING DETAIL 3 / 29 | 36~~

~~SEE BRANCH DUCT TAKE-OFF DETAIL 7 / 29 | 36~~

~~SEE MIXING BOX DETAIL 10 / 29 | 36~~

~~REMOVE FLOOR PANELS AS REQUIRED TO TEST SYSTEM.~~

GRAPHIC SCALE

1/8" = 1'-0"

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATION.

3

PLANNING DOCUMENT

SYM	DWG. NO.	ACTION	DATE	DESCRIPTION OF REVISION

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.
ENGINEER:

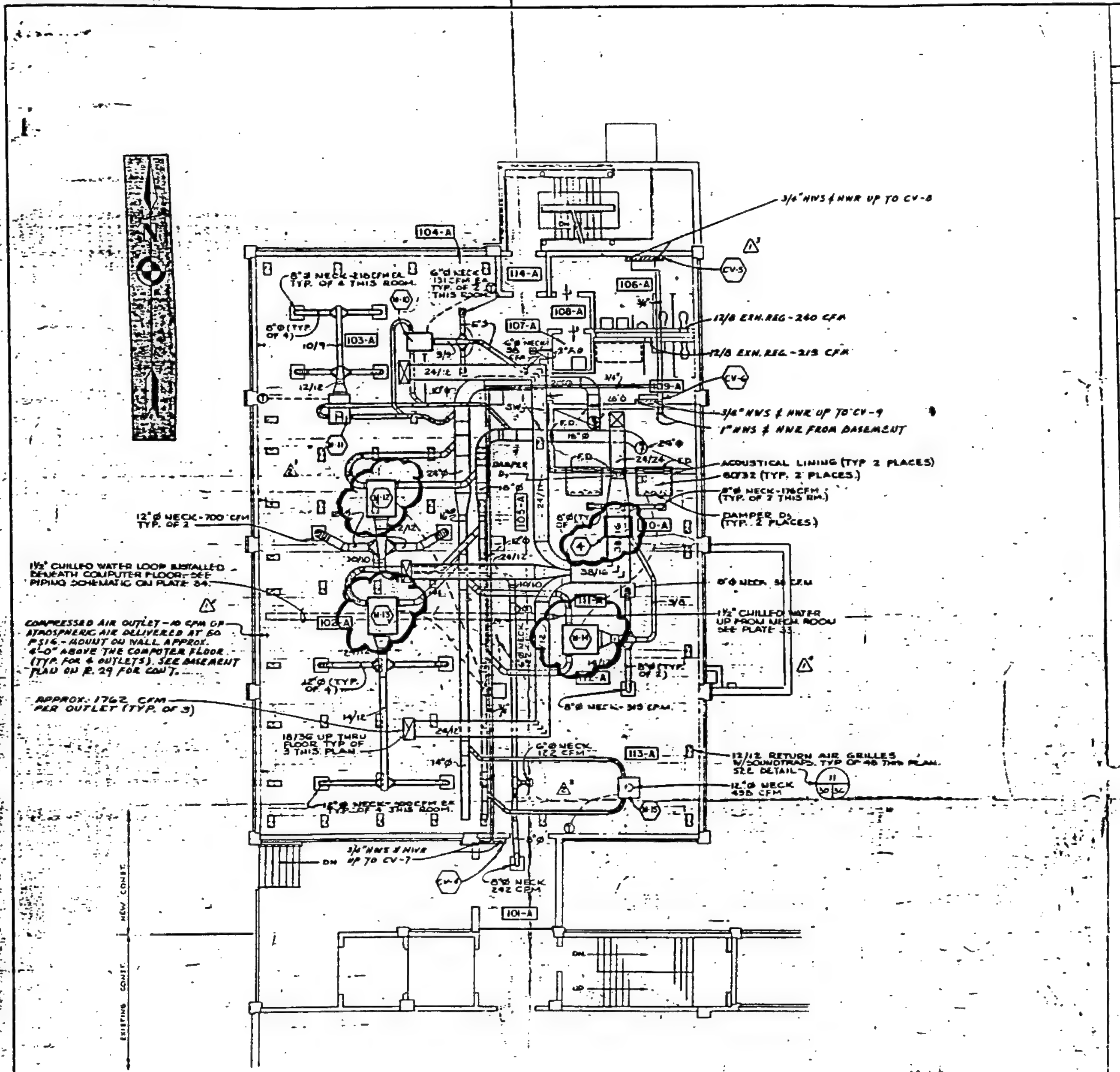
WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER WEST ADDITION
VAV RETROFIT
HVAC BASEMENT PLAN

SOL. NO. | DATED: 6–1–93
CONTR. NO.
DRAWING NUMBER: M–5 | SHEET NO. 5 OF 13 | SEQUENCE NO. 5

DRAWING OF WORK: AS-BUILT

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Mis

CORPS OF ENGINEERS



FIRST FLOOR AIR CONDITIONING PLAN

SCALE: 1/8" = 1'-0"

1

DD FORM 1391

- 3/4" HWS & HWR UP TO CV-8

EG-240 CFM

EG-213 CFM

& HWR UP TO CV-9
HWR FROM BASEMENT

AL LINING (TYP 2 PLACES)
YP. 2 PLACES)
-176CFM
THIS RM.)

PLACES)

36 CFM

D WATER
MECH. ROOM
33.

RETURN AIR GRILLES
DTRAPS. TYP OF 46 THIS PLAN.
TAIL
ECK
11
30 36

MECHANICAL EQUIPMENT SCHEDULE (CONT.)

SYMBOL	DESCRIPTION
R-1	POWER FAILURE TIMED RESET CONTROLLER PNEUMATIC OR ELECTRICAL TYPE CONTROLLER SHALL RESTART THE AIR CONDITIONING SYSTEM IN A TIMED SEQUENCE (ADJUSTABLE UP TO 12 MINUTES) IN THE EVENT OF A POWER FAILURE.
D-1	DEMINERALIZER. PACKAGED, MIXED-BED, AUTOMATIC REGENERATING TYPE COMPLETE WITH ALL NECESSARY CONTROL FOR COMPLETELY AUTOMATIC OPERATION. UNIT SHALL BE CAPABLE OF CONTINUOUSLY PRODUCING 15 GPM OF DEMINERALIZED WATER OF 200,000 OHM QUALITY FROM INPUT OF RAW WATER AS SHOWN IN THE SPECIFICATION
C-1	AIR COMPRESSOR-PACKAGED UNIT COMPLETE WITH MOTOR, COMPRESSOR, SEPARATOR, 60 GAL AIR RECEIVER. UNIT TO PRODUCE 24 CFM OF ATMOSPHERIC AIR DELIVERED AT 50 PSI APPROX. 7½ HP, 440V, 3 PHASE, 60 CYCLE.

MECHANICAL EQUIPMENT SCHEDULE (C

SYMBOL	DESCRIPTION
HP-1, HP-2, CHP-1, CHP-2	PUMPS - CENTRIFUGAL, HORIZONTAL, END SUCTION, 1750 RPM, 440 VOLT, 3 PHASE, 6

SYMBOL	GPM	FT. HEAD	APPROX. H.P.	FLUID TEMP.
HP-1	62	42	1½	180 F
HP-2	62	42	1½	180 F
CHP-1	204	77	7½	45 F
CHP-2	204	77	7½	45 F

SYMBOL	DESCRIPTION
HWCP-1	HOT WATER CIRCULATING PUMP - CENTRIFUGAL-IN-THE-LINE TYPE, 2 GPM AT 20 F 1/12 H.P. MOTOR, 1750 RPM, 115 VOLT, 1 PHASE, 60 CYCLE MOTOR.
CV-1 THRU CV-9	CONVECTORS- FINNED TUBE COMPLETE WITH MANUAL DAMPER AND AIR VENT, 10 F WATER P.D.

SYMBOL	CAP. BTUH	ENT. WATER	DEPTH	APPROX. HEIGHT	APPRO LENGT
CV-1	5312	180°F	8"	18"	28"
CV-2	12586	180°F	8"	26"	56"
CV-3	11018	180°F	8"	26"	48"
CV-4	9574	180°F	8"	26"	44"
CV-5	15239	180°F	8"	26"	64"
CV-6	9935	180°F	8"	26"	44"
CV-7	10927	180°F	8"	26"	48"
CV-8	14277	180°F	8"	26"	64"
CV-9	9935	180°F	8"	26"	44"

SYMBOL	DESCRIPTION
ET-1, ET-2	EXPANSION TANK- A.S.M.E. CONSTRUCTED, 30 PSIG WORKING PRESSURE, COMPLE INSPECTION OPENING.

SYMBOL	MINIMUM CAPACITY
ET-1	120 GAL.
ET-2	24 GAL.

SYMBOL	DESCRIPTION
M-1 THRU M-18	MIXING BOXES- MECHANICAL CONSTANT VOLUME TYPE WITH DISCHARGE AS SHOW VALVE CHAMBER SECTION, MECHANICAL CONSTANT VOLUME REGULATOR S SECTION.

SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM	SYMBOL	T
M-1	1165	M-8	1662	M-15	
M-2	518	M-9	650	M-16	
M-3	516	M-10	360	M-17	
M-4	292	M-11	874	M-18	
M-5	258	M-12	1886		
M-6	426	M-13	2000		
M-7	311	M-14	978		

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE:
   - ●- DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - ●- VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-12 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.
4. PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.
5. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

PLANNING DOCU

GRAPHIC SCALES
1/8"=1'-0"

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS

SYM | DWG NO | ACTION | DATE | DESCRIPTION OF REVIS

EMC
E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINE
CORPS
FORT

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.
ENGINEER:

WHITE SANDS MISSILE RANGE
ECIP HVAC/LIGHTING UPGRADE
RANGE CONTROL CENTER W
VAV RETROFI
HVAC FIRST FLOOI

SOL. NO.
CONTR. NO.
DRAWING NUMBER
M-6

2

DRAWING OF WORK AS-BUILT

4. PROJECT TITLE	5. PROJECT NUMBER
ECIP HVAC/Lighting Upgrade – Bldg. 300	

U.S. ARMY

EQUIPMENT SCHEDULE (CONT.)

DESCRIPTION
CONTROLLER ELECTRICAL TYPE CONTROLLER SHALL RESTART THE AIR SYSTEM IN A TIMED SEQUENCE (ADJUSTABLE UP TO 12 MINUTES) OF A POWER FAILURE.
...ER, AUTOMATIC REGENERATING TYPE COMPLETE WITH ALL CONTROL FOR COMPLETELY AUTOMATIC OPERATION. UNIT SHALL OF CONTINUOUSLY PRODUCING 15 GPH OF DEMINERALIZED WATER QUALITY FROM INPUT OF RAW WATER AS SHOWN IN THE ...
...UIT COMPLETE WITH MOTOR, COMPRESSOR, SEPARATOR, 60 GAL. AIR ... UNIT TO PRODUCE 24 CFM OF ATMOSPHERIC AIR DELIVERED APPROX. 7½ HP, 460V, 3 PHASE, 60 CYCLE.

MECHANICAL EQUIPMENT SCHEDULE (CONT.)

SYMBOL	DESCRIPTION
HP-1, HP-2, CHP-1, CHP-2	PUMPS – CENTRIFUGAL, HORIZONTAL, END SUCTION, 1750 RPM, 460 VOLT, 3 PHASE, 60 CYCLE MOTOR.

SYMBOL	GPM	FT. HEAD	APPROX. H.P.	FLUID TEMP.
HP-1	62	42	1½	180 F
HP-2	62	42	1½	180 F
CHP-1	204	77	7½	45 F
CHP-2	204	77	7½	45 F

SYMBOL	DESCRIPTION
HWCP-1	HOT WATER CIRCULATING PUMP – CENTRIFUGAL-IN-THE-LINE TYPE, 2 GPM AT 20 FT. HEAD. APPROX. 1/12 H.P. MOTOR, 1750 RPM, 115 VOLT, 1 PHASE, 60 CYCLE MOTOR.
CV-1 THRU CV-9	CONVECTORS– FINNED TUBE COMPLETE WITH MANUAL DAMPER AND AIR VENT, 30 F WATER T.D., 1 FT. MAX. WATER P.D.

SYMBOL	CAP. BTUH	ENT. WATER	DEPTH	APPROX. HEIGHT	APPROX. LENGTH	REMARKS
CV-1	5342	180°F	8"	18"	28"	WALL HUNG TYPE
CV-2	12586	180°F	8"	26"	56"	WALL HUNG TYPE
CV-3	11018	180°F	8"	26"	48"	WALL HUNG TYPE
CV-4	9574	180°F	8"	26"	44"	WALL HUNG TYPE
CV-5	15230	180°F	8"	26"	64"	WALL HUNG TYPE
CV-6	9935	180°F	8"	26"	44"	WALL HUNG TYPE
CV-7	10927	180°F	8"	26"	48"	WALL HUNG TYPE
CV-8	14277	180°F	8"	26"	64"	WALL HUNG TYPE
CV-9	9935	180°F	8"	26"	44"	WALL HUNG TYPE

SYMBOL	DESCRIPTION
ET-1, ET-2	EXPANSION TANK– A.S.M.E. CONSTRUCTED, 30 PSIG WORKING PRESSURE, COMPLETE WITH SIGHT GAGE AND INSPECTION OPENING.

SYMBOL	MINIMUM CAPACITY
ET-1	120 GAL.
ET-2	24 GAL.

SYMBOL	DESCRIPTION
M-1 THRU M-18	MIXING BOXES– MECHANICAL CONSTANT VOLUME TYPE WITH DISCHARGE AS SHOWN. UNIT TO CONSIST OF A VALVE CHAMBER SECTION, MECHANICAL CONSTANT VOLUME REGULATOR SECTION, AND A ATTENUATOR SECTION.

SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM
M-1	1165	M-8	1662	M-15	493
M-2	518	M-9	650	M-16	1797
M-3	316	M-10	360	M-17	1797
M-4	292	M-11	874	M-18	259
M-5	258	M-12	1886		
M-6	426	M-13	2000		
M-7	311	M-14	978		

...G SHOWS LOCATIONS OF THE ...DUCT MIXING BOXES TO BE ...ED WITH DUAL DUCT VAV BOXES.

...TERMINAL UNITS TO BE INSERTED IN ...NGLE ZONE AIR SYSTEM DUCTWORK.

...TIES AND LOCATIONS OF WORK FOR THE ...CT ARE INDICATED BY HEAVY LINE CLOUDING.

...R DRAWING M-11 APPLY TO ALL EXISTING MIXING BOX LOCATIONS.

...V TERMINAL UNIT IN EXISTING SINGLE ZONE DUCTWORK.

...R DRAWING M-12 APPLY TO THE VAV ...NIT LOCATIONS.

GRAPHIC SCALES
1/8"=1'-0"

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

3

PLANNING DOCUMENT

SYM	DWG. NO.	ACTION	DATE	DESCRIPTION OF REVISION

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

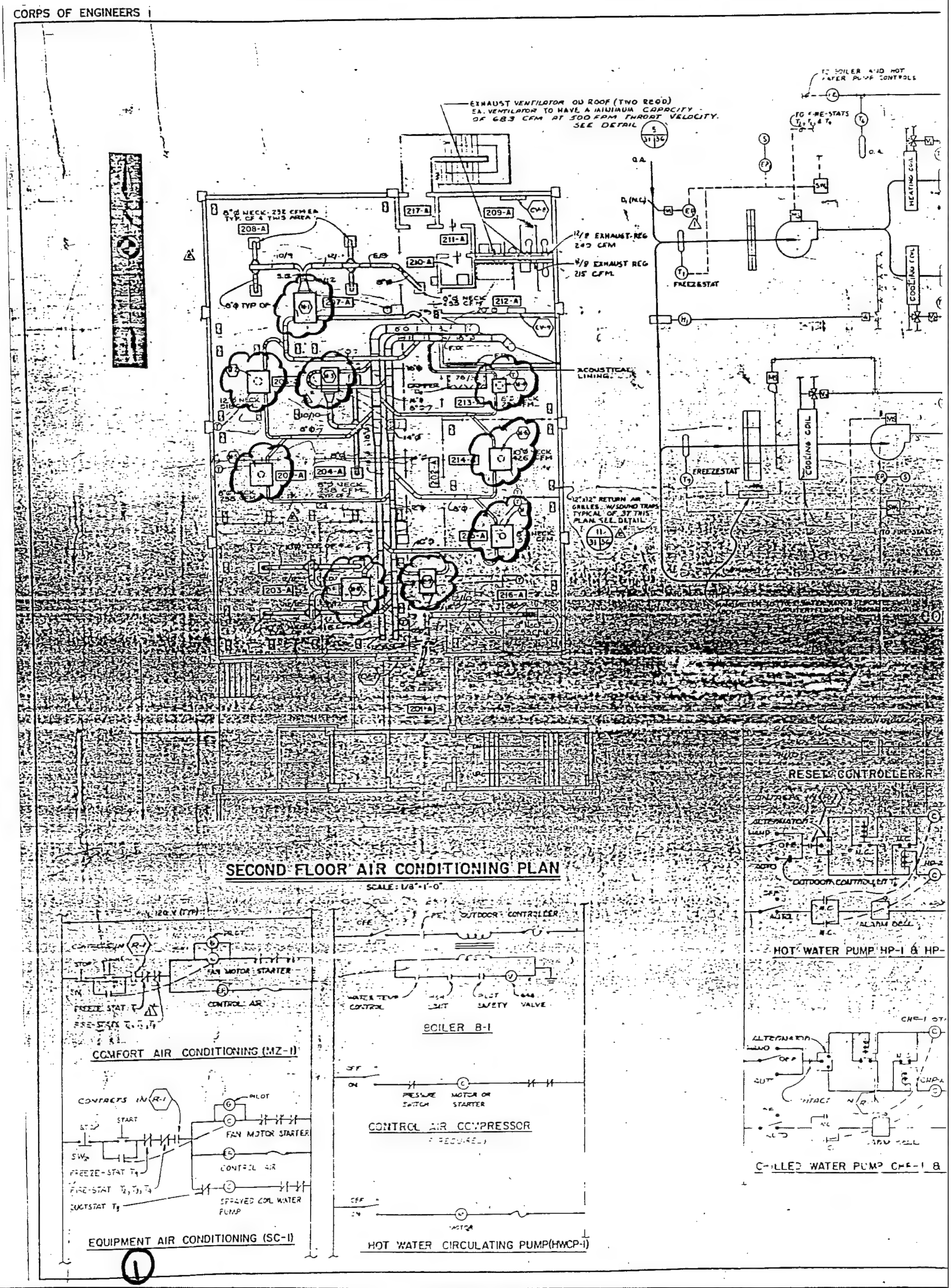
DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER WEST ADDITION
VAV RETROFIT
HVAC FIRST FLOOR PLAN

SUBMITTED BY: A.J.N.
ENGINEER:
SOL. NO.
DATED: 6–1–93
CONTR. NO.
DRAWING NUMBER: M–6
SHEET NO. 6 OF 13
SEQUENCE NO. 6

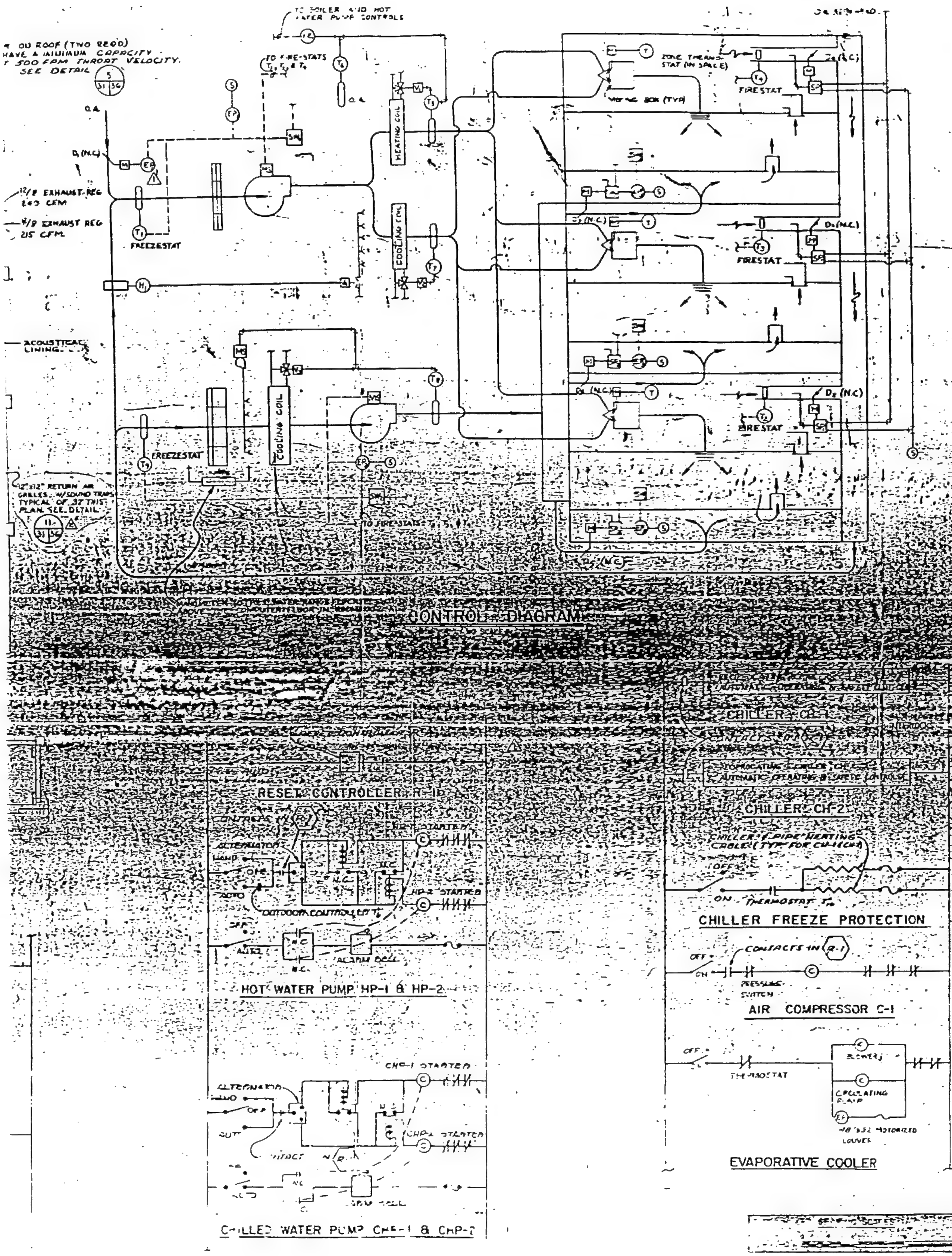
DRAWING OF WORK AS-BUILT

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION	2. DATE	3. INSTALLATION AND L
ARMY	PROJECT DATA	3 AUG 93	White Sands Missi



1

2. DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
3 AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldg.



CONTROL SE

COMFORT AIR CONDITIONING (MZ-1)

1. CLOSING SWITCH SW_1 ENERGIZES THE CONTRO… OUTSIDE AIR DAMPER … STARTS THE F…
2. STATIC PRESSURE CONTROLLERS SP_1 (ONE E… D_2, D_3 & D_4 TO MAINTAIN 0.5 IN. W.G. POST… SPACE WITH RESPECT TO THE OUTSIDE.
3. FREEZE-STAT T_1 WILL OPEN SW_1 IF THE MIX… BELOW 40°F.
4. FIRE-STATS T_2, T_3, OR T_4 WILL OPEN SWITC… TEMPERATURE FROM ANY FLOOR RISES TO 135…
5. DUCT-STAT T_5 MODULATES MIXING VALVE V… TURE. OUT DOOR CONTROLLER T_6 RESETS H… THE OUTDOOR TEMPERATURE DROPS. HOT DEC… MAXIMUM (120°F) WHEN THE OUTDOOR TEMPE… BE MINIMUM (MIXED AIR TEMPERATURE) WHE… RISES TO 65°F.
6. DUCT-STAT T_7 MODULATES MIXING VALVE V_2… TEMPERATURE AT 55°F DB.
7. ZONE THERMOSTAT "T" MODULATES THE MIXI… SPACE TEMPERATURE AT 75°F DB.
8. HUMIDSTAT H_1 LOCATED IN THE RA STREAM… VALVE V_4 TO HOLD A 40% TO 50% RH.

EQUIPMENT AIR CONDITIONING (SC-1)

1. CLOSING SWITCH SW_2 ENERGIZES THE CONT… STARTS THE FAN…
2. DUCT-STAT T_8 MODULATES MIXING VALVE V… PLENUM ENTERING AIR TEMPERATURE AT 55°… PUMP IN AN ON-OFF MANNER.
3. STATIC PRESSURE CONTROLLERS SP_2 (ONE … D_5, D_6 & D_7 TO MAINTAIN 1.0 IN W.G. … THE FLOOR PLENUM WITH RESPECT TO THE…
4. FREEZE-STAT T_9 OPENS SWITCH SW_2 WHEN T… DROPS TO 40°F DB.

NOTES:

1. THIS DRAWING SHOWS LOCAT…
   - DUAL DUCT MIXING BOX… REPLACED WITH DUAL D…
2. DRAWING NOTES AND LOCATI… ECIP PROJECT ARE INDICATE…
3. DETAILS PER DRAWING M-11… DUAL-DUCT MIXING BOX LOC…

PLANNING

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

DESIGNED BY: C.H.B.	WHITE SANDS …
DRAWN BY: M.D.C.	ECIP HVAC/LIGH… RANGE CONTR…
REVIEWED BY: D.L.D.	V… HVAC SE…
SUBMITTED BY: A.J.N.	
ENGINEER:	

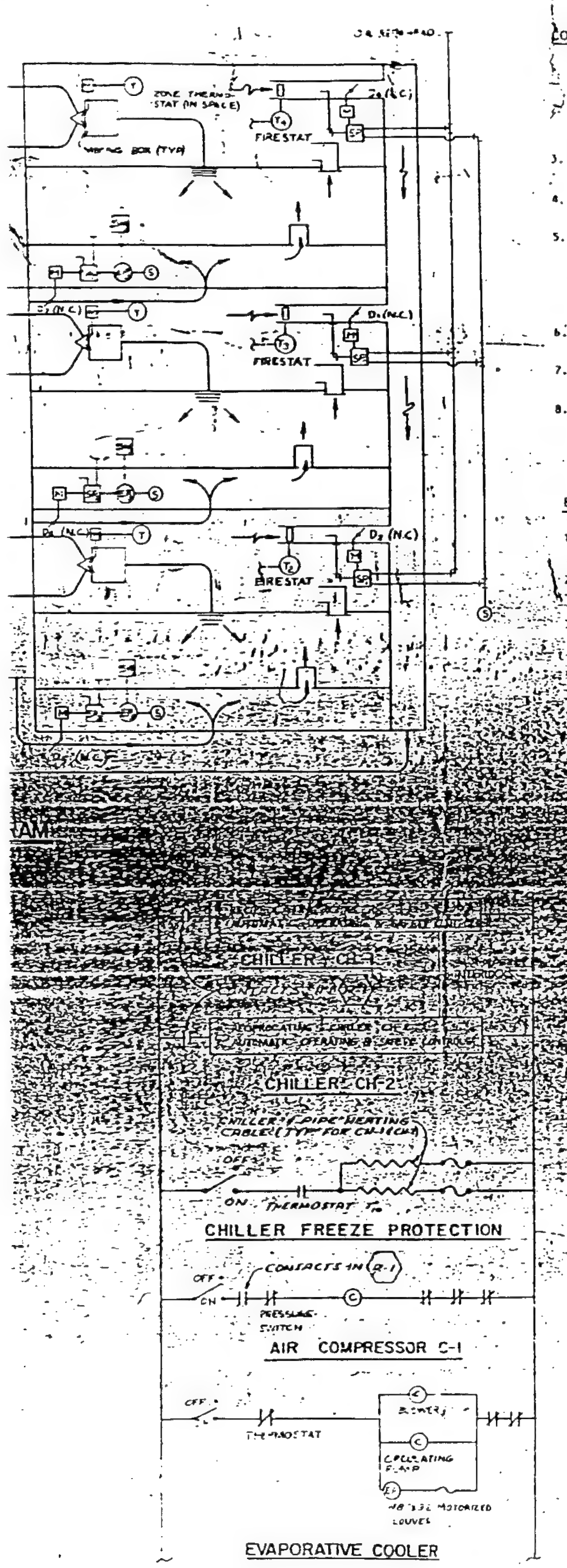
CP-1

(2)

DRAWING OF WORK AS-BUILT

, NM	4. PROJECT TITLE ECIP HVAC/Lighting Upgrade – Bldg. 300	5. PROJECT NUMBER

U.S. ARMY



CONTROL SEQUENCE

COMFORT AIR CONDITIONING (MZ-1)

1. CLOSING SWITCH SW_1 ENERGIZES THE CONTROL CIRCUIT THRU EP_1, OPENING OUTSIDE AIR DAMPER D_1 AND STARTS THE FAN.
2. STATIC PRESSURE CONTROLLERS SP_1 (ONE EACH FLOOR) MODULATE DAMPERS D_2, D_3 & D_4 TO MAINTAIN 0.5 IN. W.G. POSTIVE STATIC PRESSURE IN THE SPACE WITH RESPECT TO THE OUTSIDE.
3. FREEZE-STAT T_1 WILL OPEN SW_1 IF THE MIXED AIR TEMPERATURE DROPS BELOW 40°F.
4. FIRE-STATS T_2, T_3, OR T_4 WILL OPEN SWITCH SW_1 WHEN THE RETURN AIR TEMPERATURE FROM ANY FLOOR RISES TO 135°F.
5. DUCT-STAT T_5 MODULATES MIXING VALVE V_1 TO MAINTAIN HOT DECK TEMPERATURE. OUT DOOR CONTROLLER T_6 RESETS HOT DECK CONTROL POINT UP AS THE OUTDOOR TEMPERATURE DROPS. HOT DECK TEMPERATURE SHALL REACH MAXIMUM (120°F) WHEN THE OUTDOOR TEMPERATURE DROPS TO 21°F AND SHALL BE MINIMUM (MIXED AIR TEMPERATURE) WHEN THE OUTDOOR TEMPERATURE RISES TO 65°F.
6. DUCT-STAT T_7 MODULATES MIXING VALVE V_2 TO MAINTAIN THE COLD DECK TEMPERATURE AT 55°FDB.
7. ZONE THERMOSTAT "T" MODULATES THE MIXING BOX DAMPERS TO MAINTAIN SPACE TEMPERATURE AT 75°FDB.
8. HUMIDISTAT H_1 LOCATED IN THE RA STREAM WILL CONTROL TWO POSITION VALVE V_4 TO HOLD A 40% TO 50% RH.

EQUIPMENT AIR CONDITIONING (SC-1)

1. CLOSING SWITCH SW_2 ENERGIZES THE CONTROL CIRCUIT THRU EP_2 AND STARTS THE FAN.
2. DUCT-STAT T_8 MODULATES MIXING VALVE V_3 TO MAINTAIN THE FLOOR PLENUM ENTERING AIR TEMPERATURE AT 55°FDB AND CONTROLS CIRCULAT[illegible] PUMP IN AN ON-OFF MANNER.
3. STATIC PRESSURE CONTROLLERS SP_2 (ONE EACH FLOOR) MODULATE DAMPERS D_5, D_6, & D_7 TO MAINTAIN 1.0 IN W.G. POSITIVE STATIC PRESSURE IN THE FLOOR PLENUM WITH RESPECT TO THE SPACE ABOVE THE PLENUM.
4. FREEZE-STAT T_9 OPENS SWITCH SW_2 WHEN THE RETURN AIR TEMPERATURE DROPS TO 40°FDB.
5. FIRE-STATS [illegible] WILL OPEN SWITCH SW_2 WHEN THE RETURN AIR TEMPERATURE FROM ANY FLOOR RISES TO 135°F [illegible]
6. [illegible]

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.

PLANNING DOCUMENT

NOTE: ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK SHALL BE DONE IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE CORPS OF ENGINEERS MANUAL "GENERAL SAFETY REQUIREMENTS" AND THE CONTRACT SPECIFICATIONS.

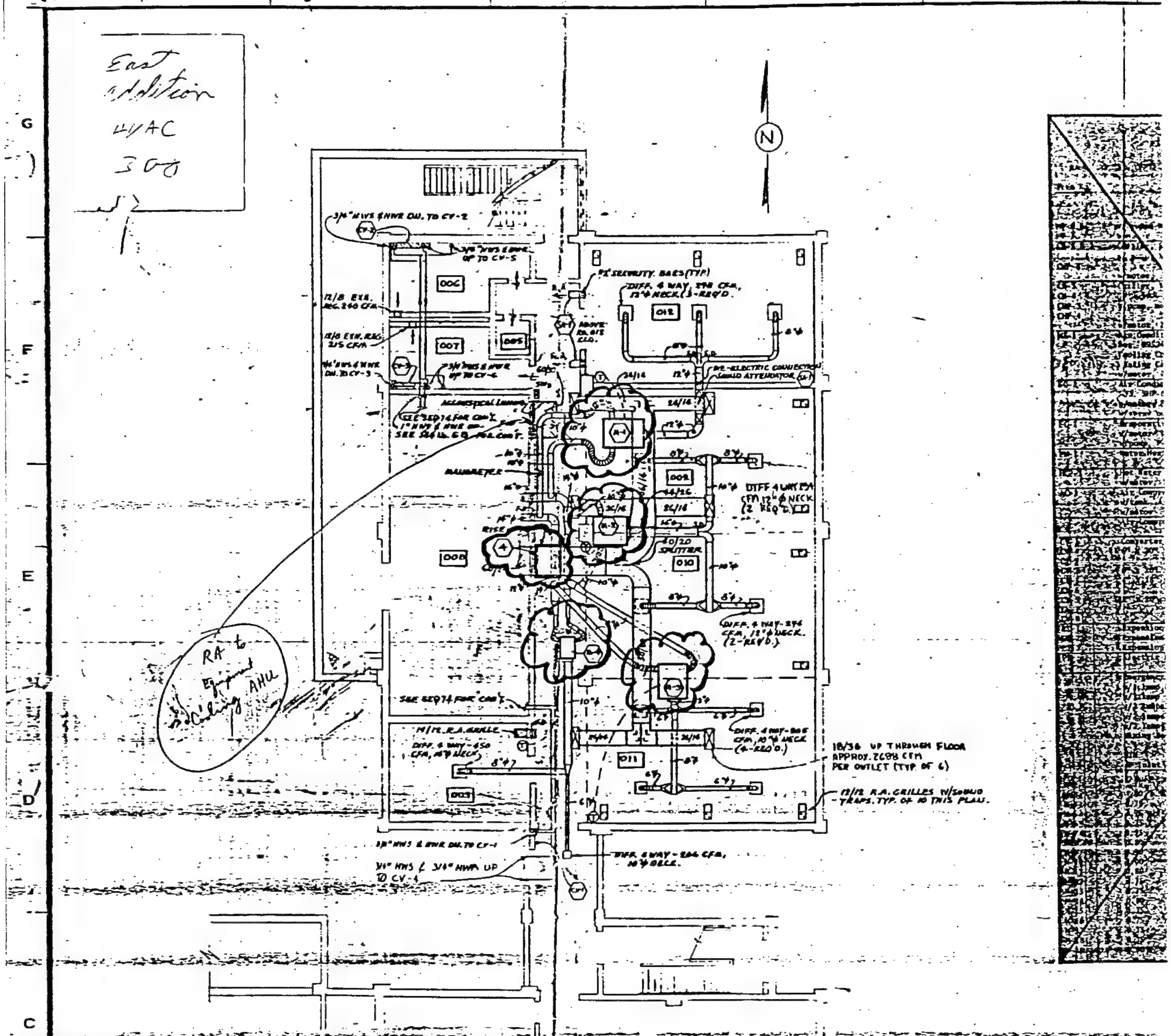
E M C ENGINEERS INC. 2750 S WADSWORTH DENVER, COLORADO DENVER ATLANTA	U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
DESIGNED BY: C.H.B. DRAWN BY: M.D.C. REVIEWED BY: D.L.D. SUBMITTED BY: A.J.N. ENGINEER:	WHITE SANDS MISSILE RANGE, NEW MEXICO ECIP HVAC/LIGHTING UPGRADE–BUILDING 300 RANGE CONTROL CENTER WEST ADDITION VAV RETROFIT HVAC SECOND FLOOR PLAN
SOL. NO.	DATED: 6–1–93
CONTR. NO.	SEQUENCE NO. 7
DRAWING NUMBER M-7	SHEET NO. 7 OF 13

3

DRAWING OF WORK AS-BUILT

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Miss

East Addition
HVAC
300



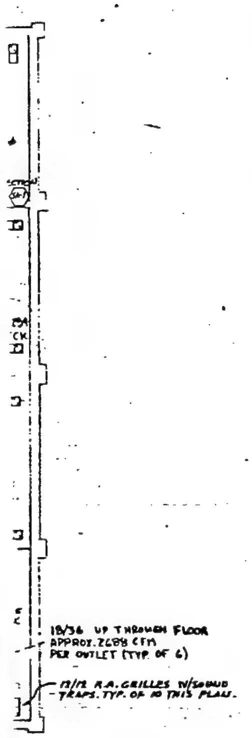
BASEMENT FLOOR AIR CONDITIONING PLAN

SCALE: 1/8" = 1'0"

(1)

DD FORM 1391c

[illegible]



MECHANICAL EQUIPMENT SCHEDULE

NOTE: ALL QUANTITIES GIVEN IN THE EQUIPMENT SCHEDULE ARE ELEV. UNLESS OTHERWISE NOTED.

SYMBOL	DESCRIPTION
B-1	BOILER – NATURAL GAS FIRED PACKAGED HOT WATER BOILE… WATER TEMP). STEEL, SBI OR AGA RATE… PRESSURE. ORIFICED FOR 4000 FT. ELEV. OPERATION. … AT S.L.
CH-1 THRU CH-4	CHILLER – PACKAGED AIR COOLED TYPE COMPLETE W/OPEN… SEALED RECIPROCATING COMPRESSOR(S), INSULATED DIRE… SHELL AND TUBE TYPE EVAPORATOR, AIR COOLED CONDEN… OPERATING AND SAFETY CONTROLS. CHILLERS SHALL H… SHOWN WHILE OPERATING WITH A SOLUTION OF 75% WATE… ETHYLENE GLYCOL BY WEIGHT. 100°FDB AMBIENT AIR. T… AND CHILLED WATER PIPING SHALL BE PROVIDED W/HEAT… UNDER THE INSULATION WITH CAPACITY TO PROTECT THE… AND PIPING FROM FREEZING DOWN TO 0°FDB AMBIENT. … PHASE, 60 CYCLE MOTOR. COMPRESSORS SHALL HAVE 4 STEP CAPACITY REDUCTION (80%, 60%, 40% & 20%)

	EVAPORATOR					AIR COOLED CONDENSER		
	ETHYLENE GLYCOL SOL.				COOLING LOAD BTUH			
SYMBOL	ENT.	LVG.	GPM	MAX. P.D.		APPROX. H.P.	MAX. RU T.S.	AP…
CH-1	50	40	118	16	505,547	7½	9760	—
CH-2	50	40	118	16	505547	7½	9760	—
CH-3	50	40	200	[illegible]	912,000	2-5	5270	—
CH-4	50	40	200	[illegible]	912,000	2-5	5270	—

AZ-1 COMFORT AIR CONDITIONING UNIT – PACKAGED MULTI-ZONE UNIT DOUBLE DUCT ADAPTOR, HOT WATER COIL, CHILLED WATER COIL, ATOMIZING SPRAY HUMIDIFIER. 440 VOLT, 3 PHASE, 60 CYCLE …

FAN CAPACITY	EXT. STATIC PRESS.	APPROX. H.P.	APPROX. R…
14,180 CFM	3.1" W.G.	25	1230

COOLING COIL CAP	CFM	ENT. AIR TEMP.	LVG. AIR TEMP	ENT. COOLANT*	LV COOLANT*	GPM
410,010	14,180	80 FDB 61 FWB	55°FDB 49°FWB	40°F	50°F	91

HTG. COIL CAP.	CFM	ENT. AIR TEMP.	LVG. AIR TEMP.	GPM	MIN. FACE AREA	MAX. P.D
340,590	7,640	66.1°F	114°F	34	11 FT.²	5

*COOLANT IS A SOLUTION OF 75% WATER & 25% ETHYLENE GLYC…
ATOMIZING SPRAY HUMIDIFIER – UNIT TO PRODUCE 100 LBS. OF …

SC-1 EQUIPMENT AIR CONDITIONING UNIT – PACKAGED SPRAYED COILS W/SPRAYED COIL, PUMP, FAN & MOTOR. 440 VOLT, 3 PHASE, …

COOLING COIL CAP	CFM	ENT. AIR TEMP.*	LVG. AIR TEMP.	ENT COOLANT*	LVG. COOLANT*	GPM	MA… P.…
659,354	32,260	71.6 DB 59.4 WB	52°F DB 51°F WB	40°F	55°F	145	1C…

FAN CAPACITY	EST. STATIC PRESS.	APPROX. H.P.	APPROX. REM.
32,260 CFM	3.50" W.G.	40	1020

*COIL COOLANT IS A SOLUTION OF 75% WATER & 25% ETHYLE…

SYMBOL	DESCRIPTION
EC-1	EVAPORATIVE COOLER – SIDE DISCHARGE TYPE COMPLETE W/F… VALVE AND RECIRCULATING PUMP – 7000 CFM @ 1/8" W.G. EX… H.P. 208 V, 3 PHASE, 60 CYCLE FAN MOTOR. RECIRCULATING P… 115V, W/ BLEED OFF
WH-1	HOT WATER HEATER – STORAGE TYPE, AGA RATED, ORIFICED F… ELEV. 50000 BTUH SEA LEVEL INPUT. 60 GPH. SEA LEV… 100°F RISE. 40 GAL. STORAGE TANK, NATURAL GAS FUE…
HCP-1	HOT WATER CIRCULATING PUMP – CENTRIFUGAL-IN-THE-LINE … HD. APPROX: 1/12 H.P. MOTOR, 1750 RPM, 115V, 1φ, 60 Hz. …
AC-1	AIR COMPRESSOR – FOR PNEUMATIC CONTROLS SYSTEMS – DUPLE… COOLED, COMPLETE W/80 GAL. STORAGE TANK, ELECTRIC… DRIVES, CONTROLS (INCLUDING ALTERNATOR), ASME APP… REFRIGERANT DRYER SIZED FOR COMPRESSOR (SEE … TO BE SIZED AS RECOMMENDED BY CONTROLS MFR. 5.7 C… (MIN) @ 100 PSIG, 1½ HP, 208V, 3φ, 60 HZ
SA-1	SOUND ATTENUATOR – 2000 FPM FACE VELOCITY 0.2" W.G. PRESSURE DROP.

NOTE

1. FOR DETAILS SEE SEQ. 75
2. SEE SEQ. 71 FOR LEGEND

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.
4. PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.
5. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

PLANNING DOCU…

REV	DWG. NO.	ACTION	DATE	…

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENG…
CO…
FO…

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.
ENGINEER:

WHITE SANDS MISSILE RANG…
ECIP HVAC/LIGHTING UPGRA…
RANGE CONTROL CENTER
VAV RETRO…
HVAC BASEMEN…

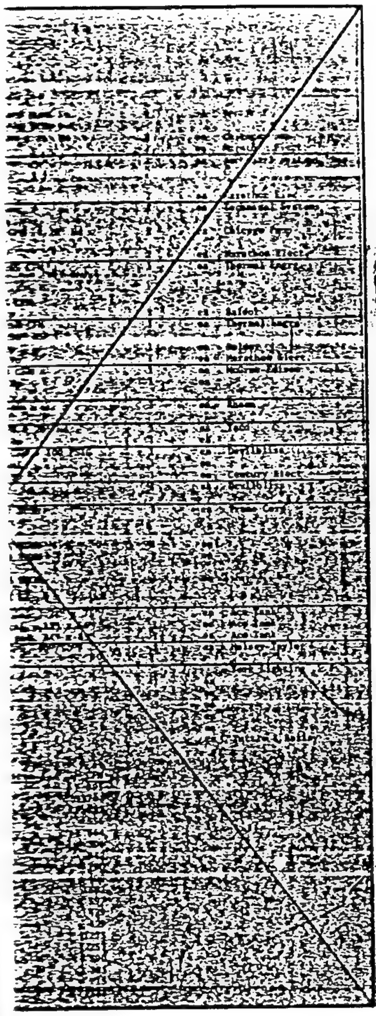
SOL. NO.
CONTR. NO.
DRAWING NUMBER M-8

②

4. PROJECT TITLE

ECIP HVAC/Lighting Upgrade – Bldg. 300

5. PROJECT NUMBER



MECHANICAL EQUIPMENT SCHEDULE

NOTE: ALL QUANTITIES GIVEN IN THE EQUIPMENT SCHEDULE ARE FOR 4000 FT. ELEV. UNLESS OTHERWISE NOTED.

SYMBOL	DESCRIPTION
B-1	BOILER - NATURAL GAS FIRED PACKAGED HOT WATER BOILER (180°F. MAX WATER TEMP). STEEL, SBI OR AGA RATED. 30 [illegible] MAX. OPERATING PRESSURE. ORIFICED FOR 4000 FT. ELEV. OPERATION. 40[illegible],000 BTUH OUTPUT AT S.L.
CH-1 THRU CH-4	CHILLER - PACKAGED AIR COOLED TYPE COMPLETE W/OPEN OR HERMETICALLY SEALED RECIPROCATING COMPRESSOR(S). INSULATED DIRECT EXPANSION SHELL AND TUBE TYPE EVAPORATOR, AIR COOLED CONDENSOR AND COMPLETE OPERATING AND SAFETY CONTROLS. CHILLERS SHALL HAVE THE CAPACITY SHOWN WHILE OPERATING WITH A SOLUTION OF 75% WATER AND 25% ETHYLENE GLYCOL BY WEIGHT. 100°FDB AMBIENT AIR. THE EVAPORATOR AND CHILLED WATER PIPING SHALL BE PROVIDED W/HEATING CABLE UNDER THE INSULATION WITH CAPACITY TO PROTECT THE EVAPORATOR AND PIPING FROM FREEZING DOWN TO 0°FDB AMBIENT. 440 VOLT, 3 PHASE, 60 CYCLE MOTOR. COMPRESSORS SHALL HAVE 4 STEPS OF CAPACITY REDUCTION (80%, 60%, 40% & 20%)

	EVAPORATOR					AIR COOLED CONDENSER		REFRIGERANT COMPRESSORS
	ETHYLENE GLYCOL SOL.				COOLING LOAD BTUH			
SYMBOL	ENT.	LVG.	GPM	MAX. P.D.		APPROX. H.P.	MAX. MBTU T.S.	APPROX. KW. INPUT
CH-1	50	40	118	16	505,547	7½	9760	51.5
CH-2	50	40	118	16	505,547	7½	9760	51.5
CH-3	50	40	200	18.4	912,000	2-5	5270	79.7
CH-4	50	40	200	18.4	912,000	2-5	5270	79.7

AC-1 — COMFORT AIR CONDITIONING UNIT - PACKAGED MULTI-ZONE UNIT COMPLETE WITH DOUBLE DUCT ADAPTER, HOT WATER COIL, CHILLED WATER COIL, FAN, MOTOR AND ATOMIZING SPRAY HUMIDIFIER. 440 VOLT, 3 PHASE, 60 CYCLE MOTOR.

FAN CAPACITY	EXT. STATIC PRESS.	APPROX. H.P.	APPROX. RPM
14,180 CFM	3.1" W.G.	25	1230

COOLING COIL CAP	CFM	ENT. AIR TEMP.	LVG. AIR TEMP	ENT COOLANT*	LV COOLANT*	GPM	MAX. P.D	MAX. COIL FACE VEL.	AIR P.D.
410,040	14,180	80 FDB 61 FWB	55°FDB 49°FWB	40°F	50°F	91	10.0	500 FPM	0.8

HTG. COIL CAP.	CFM	ENT. AIR TEMP.	LVG. AIR TEMP.	GPM	MIN. FACE AREA	MAX. P.D	AIR P.D.	ENT. WATER
340,590	7,640	66.1°F	114°F	34	11 FT.²	5	0.24	180°F

*COOLANT IS A SOLUTION OF 75% WATER & 25% ETHYLENE GLYCOL BY WEIGHT
ATOMIZING SPRAY HUMIDIFIER - UNIT TO PRODUCE 100 LBS. OF WATER VAPOR PER HOUR

SC-1 — EQUIPMENT AIR CONDITIONING UNIT - PACKAGED SPRAYED COILS, UNIT COMPLETE W/SPRAYED COIL, PUMP, FAN & MOTOR. 440 VOLT, 3 PHASE, 60 CYCLE MOTOR

COOLING COIL CAP	CFM	ENT AIR TEMP.*	LVG. AIR TEMP.	ENT COOLANT*	LVG COOLANT*	GPM	MAX P.D.	MAX COIL FACE VEL.	AIR P.D
659,354	32,260	71.6 DB 59.4 WB	52°F DB 51°F WB	40°F	55°F	145	10	500	0.8

FAN CAPACITY	EXT. STATIC PRESS.	APPROX. H.P.	APPROX. RPM
32,260 CFM	3.5" W.G.	40	1020

*COIL COOLANT IS A SOLUTION OF 75% WATER & 25% ETHYLENE GLYCOL BY WEIGHT.

SYMBOL	DESCRIPTION
EC-1	EVAPORATIVE COOLER - SIDE DISCHARGE TYPE COMPLETE W/FAN, MOTOR, FLOAT VALVE AND RECIRCULATING PUMP - 7000 CFM @ 1/8" W.G. EXT. S.P. APPROX. 3/4 H.P. 208 V, 3 PHASE, 60 CYCLE FAN MOTOR. RECIRCULATING PUMP APPROX. 115 V. W/ BLEED OFF
WH-1	HOT WATER HEATER - STORAGE TYPE, AGA RATED, ORIFICED FOR 4000 FT. ELEV. 50000 BTUH SEA LEVEL INPUT. 60 GPH. SEA LEVEL RECOVERY @ 100°F RISE. 40 GAL. STORAGE TANK, NATURAL GAS FUEL
HCP-1	HOT WATER CIRCULATING PUMP - CENTRIFUGAL - IN-THE-LINE TYPE 5 GPM @ 20 FT. HD. APPROX: 1/12 H.P. MOTOR, 1750 RPM, 115V, 1φ, 60 Hz. MOTOR
AC-1	AIR COMPRESSOR - FOR PNEUMATIC CONTROLS SYSTEMS - DUPLEX, TWO STAGE, AIR COOLED, COMPLETE W/80 GAL. STORAGE TANK, ELECTRIC MOTORS, BELT DRIVES, CONTROLS (INCLUDING ALTERNATOR), ASME APPROVED TANK. REFRIGERANT DRYER SIZED FOR COMPRESSOR (SEE DETAIL) TO BE SIZED AS RECOMMENDED BY CONTROLS MFR. 5.7 CFM FREE AIR (MIN) @ 100 PSIG, 1½ HP, 208V, 3 φ, 60 HZ
SA-1	SOUND ATTENUATOR - 2000 FPM MAX. FACE VELOCITY 0.2" W.G. MAX. STATIC PRESSURE DROP

NOTE

1. FOR DETAILS SEE SEQ. 75
2. SEE SEQ. 71 FOR LEGEND

: LOCATIONS OF THE
NG BOXES TO BE
DUAL DUCT VAV BOXES.
NTS TO BE INSERTED IN
E AIR SYSTEM DUCTWORK.
LOCATIONS OF WORK FOR THE
ICATED BY HEAVY LINE CLOUDING.
M-11 APPLY TO ALL EXISTING
OX LOCATIONS.
AL UNIT IN EXISTING SINGLE ZONE
M-12 APPLY TO THE VAV
IONS.

PLANNING DOCUMENT

REV	MK	NO	ACTION	DATE	DESCRIPTION OF REVISION

C M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

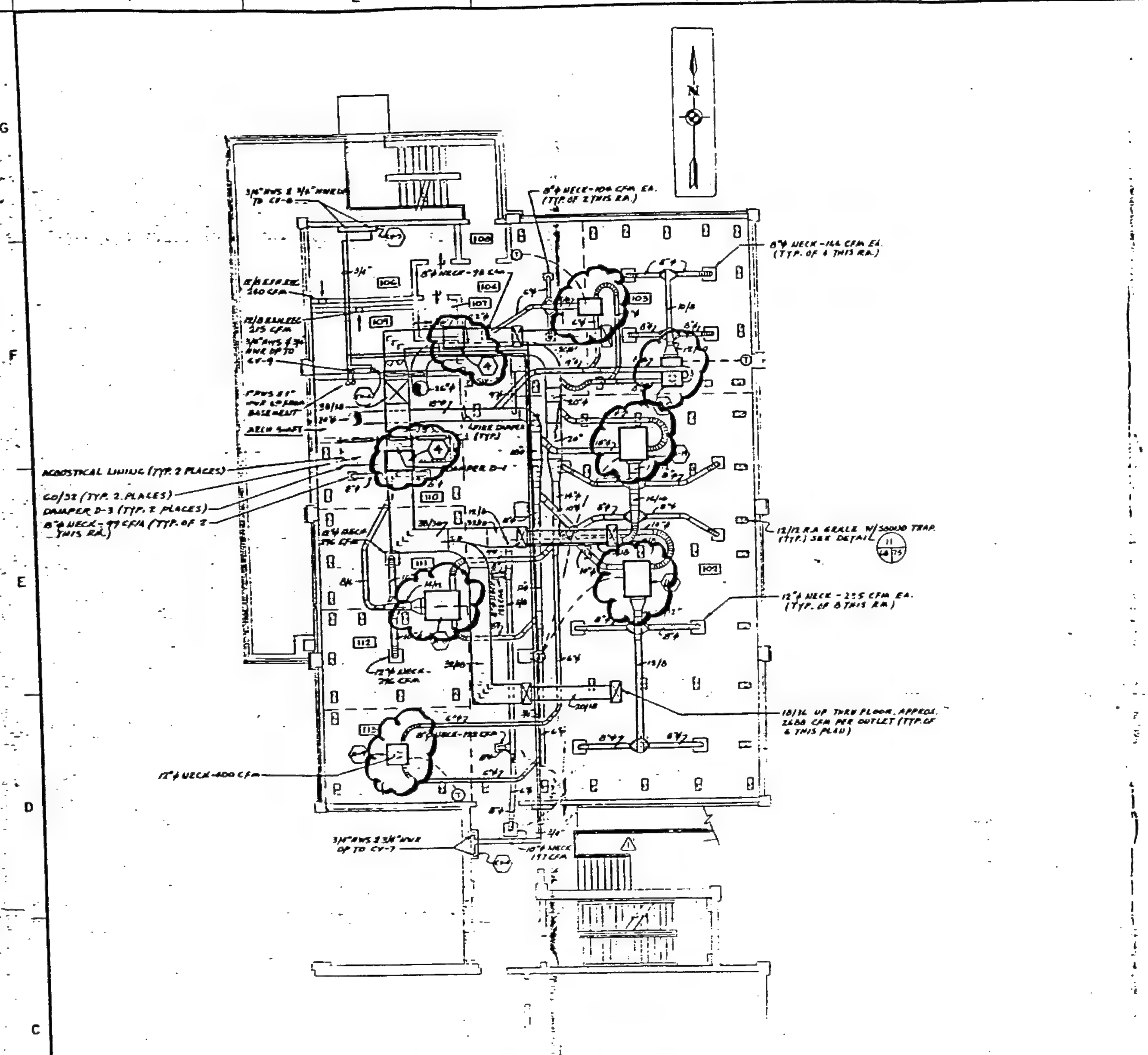
DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER EAST ADDITION
VAV RETROFIT
HVAC BASEMENT PLAN

SUBMITTED BY: A.J.N.
ENGINEER:
SOL. NO.
CONTR. NO.
DATED: 6-1-9[illegible]
DRAWING NUMBER: M-8
SHEET NO. 8 OF 13
SEQUENCE NO. 8

3

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AN[D] White Sands Mis[sile Range]



FIRST FLOOR AIR CONDITIONING PLAN

SCALE: 1/8"=1'-0"

1

DD FORM 1391c

K-166 CFM EA.
F 6 THIS RM.)

SERILE W/SOUND TRAP.
EE DETAIL 11/68.75

CK-235 CFM EA.
CF 8 THIS RM.)

P THRU FLOOR, APPROX.
FM PER OUTLET (TYP. OF
PLAN)

EQUIPMENT SCHEDULE (CON'T.)

SYMBOL	DESCRIPTION
R-1	POWER FAILURE RESET CONTROLLER - PNEUMATIC OR ELECTRI... CONTROLLER SHALL RESTART THE AIR CONDITIONING SYSTEM SEQUENCE (ADJUSTABLE UP TO 12 MINUTES) IN THE EVENT POWER FAILURE.

VOID

PUMPS - CENTRIFUGAL, HORIZONTAL, END SUCTION, 1750 RPM, 60 CYCLE MOTOR.

HP-1, HP-2, CHP-1, CHP-2, CHP-3, CHP-4

SYMBOL	GPM	FT. HEAD	APPROX. H.P.	FLUID TEMP.
HP-1	35	22	1/2	180°F
HP-2	35	22	1/2	180°F
CHP-1	236	44	5	45°F
CHP-2	236	44	5	45°F
CHP-3	400	20	3	40°F
CHP-4	400	20	3	40°F

CONVECTORS - FINNED TUBE COMPLETE W/MANUAL DAMPER AL... 10°F WATER T.D. 1 FT. MAX. WATER P.D.

CV-1 THRU CV-9

SYMBOL	CAP. BTUH	ENT. WATER	DEPTH	APPROX. HEIGHT	APPROX. LENGTH	REM...
CV-1	4165	180°F	6"	18"	26"	WALL H...
CV-2	5630	"	6"	"	32"	–
CV-3	1760	"	4"	"	20"	"
CV-4	4566	"	6"	"	36"	"
CV-5	6590	"	8"	"	32"	"
CV-6	2220	"	4"	"	24"	"
CV-7	6255	"	8"	"	32"	"
CV-8	6520	"	8"	"	32"	"
CV-9	3035	"	6"	"	24"	"

EXPANSION TANK - ASME CONSTRUCTED. 30 PSIG WORKING PRES... COMPLETE W/SIGHT GAUGE & INSPECTION OPENING.

ET-1 THRU ET-3

SYMBOL	MIN. CAPACITY.
ET-1	120 GAL.
ET-2	24 GAL.
ET-3	144 GAL.

MIXING BOXES - MECHANICAL CONSTANT VOLUME W/DISCHARGE... UNIT TO CONSIST OF A VALVE CHAMBER SECTION. MECHANIC... VOLUME REGULATOR SECTION AND A ATTENUATOR SECTIO... 0.75" W.G.

M-1 THRU M-19

SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM
M-1	895	M-9	600	M-17	383
M-2	1174	M-10	1562	M-18	715
M-3	822	M-11	597	M-19	1283
M-4	556	M-12	429		
M-5	663	M-13	429		
M-6	366	M-14	1275		
M-7	942	M-15	257		
M-8	790	M-16	390		

NOTES

1. FOR DETAILS SEE SEQ. NO. 75.
2. UNLESS OTHERWISE NOTED DIFFUSERS TO BE 4 WAY TYPE.
3. SEE SEQ-71 FOR LEGEND

NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
   - VAV TERMINAL UNITS TO BE INSERTED IN THE SINGLE ZONE AIR SYSTEM DUCTWORK.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.
4. PROVIDE VAV TERMINAL UNIT IN EXISTING SINGLE ZONE AIR SYSTEM DUCTWORK.
5. DETAILS PER DRAWING M-12 APPLY TO THE VAV TERMINAL UNIT LOCATIONS.

GRAPHIC SCALES

1/8"=1'-0"

PLANNING DOCUM...

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DIST...
CORPS OF ENG...
FORT WORTH

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.
ENGINEER:

WHITE SANDS MISSILE RANGE, NEW...
ECIP HVAC/LIGHTING UPGRADE–BUI...
RANGE CONTROL CENTER EAST A...
VAV RETROFIT
HVAC FIRST FLOOR PL...

SOL. NO.
CONTR. NO.
DRAWING NUMBER M–9
SHE... 9

②

4. PROJECT TITLE	5. PROJECT NUMBER
ECIP HVAC/Lighting Upgrade – Bldg. 300	

EQUIPMENT SCHEDULE
(CON'T.)

SYMBOL	DESCRIPTION

R-1

POWER FAILURE RESET CONTROLLER - PNEUMATIC OR ELECTRIC TYPE CONTROLLER SHALL RESTART THE AIR CONDITIONING SYSTEM IN A TIMED SEQUENCE (ADJUSTABLE UP TO 12 MINUTES) IN THE EVENT OF A POWER FAILURE.

VOID

HP-1, HP-2, CHP-1, CHP-2, CHP-3, CHP-4

PUMPS - CENTRIFUGAL, HORIZONTAL, END SUCTION, 1750 RPM, 440V, 3φ, 60 CYCLE MOTOR.

SYMBOL	GPM	FT. HEAD	APPROX. H.P.	FLUID TEMP.
HP-1	36	22	1/2	120°F
HP-2	35	22	1/2	180°F
CHP-1	236	44	5	45°F
CHP-2	236	44	5	45°F
CHP-3	400	20	3	40°F
CHP-4	400	20	3	40°F

CV-1 THRU CV-9

CONVECTORS - FINNED TUBE COMPLETE W/MANUAL DAMPER AND AIR VENT. 10°F WATER T.D. 1 FT. MAX. WATER P.D.

SYMBOL	CAP. BTUH	ENT. WATER	DEPTH	APPROX. HEIGHT	APPROX. LENGTH	REMARKS
CV-1	4165	180°F	6"	18"	26"	WALL HUNG TYPE
CV-2	5630	"	6"	"	32"	" " "
CV-3	1760	"	4"	"	20"	" " "
CV-4	4500	"	6"	"	36"	" " "
CV-5	6590	"	8"	"	32"	" " "
CV-6	2220	"	4"	"	24"	" " "
CV-7	6255	"	8"	"	32"	" " "
CV-8	6520	"	8"	"	32"	" " "
CV-9	3035	"	6"	"	24"	" " "

ET-1 THRU ET-3

EXPANSION TANK - ASME CONSTRUCTED. 30 PSIG WORKING PRESSURE. COMPLETE W/SIGHT GAUGE & INSPECTION OPENING.

SYMBOL	MIN. CAPACITY
ET-1	180 GAL.
ET-2	24 GAL.
ET-3	144 GAL.

M-1 THRU M-19

MIXING BOXES - MECHANICAL CONSTANT VOLUME W/DISCHARGE AS SHOWN. UNIT TO CONSIST OF A VALVE CHAMBER SECTION. MECHANICAL CONSTANT VOLUME REGULATOR SECTION AND A ATTENUATOR SECTION. MAX P.D. = 0.75" W.G.

SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM	SYMBOL	TOTAL CFM
M-1	895	M-9	600	M-17	383
M-2	1174	M-10	1502	M-18	715
M-3	812	M-11	597	M-19	1283
M-4	556	M-12	429		
M-5	663	M-13	429		
M-6	306	M-14	1275		
M-7	942	M-15	257		
M-8	790	M-16	390		

...OCATIONS OF THE
...BOXES TO BE
...AL DUCT VAV BOXES.
...TS TO BE INSERTED IN
AIR SYSTEM DUCTWORK.
...OCATIONS OF WORK FOR THE
...CATED BY HEAVY LINE CLOUDING.
...–11 APPLY TO ALL EXISTING
LOCATIONS.
UNIT IN EXISTING SINGLE ZONE
...–12 APPLY TO THE VAV

NOTES

1. FOR DETAILS SEE SEQ. NO. 75.
2. UNLESS OTHERWISE NOTED DIFFUSERS TO BE 4 WAY TYPE.
3. SEE SEQ-71 FOR LEGEND

GRAPHIC SCALES

1/8"=1'-0"

PLANNING DOCUMENT

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

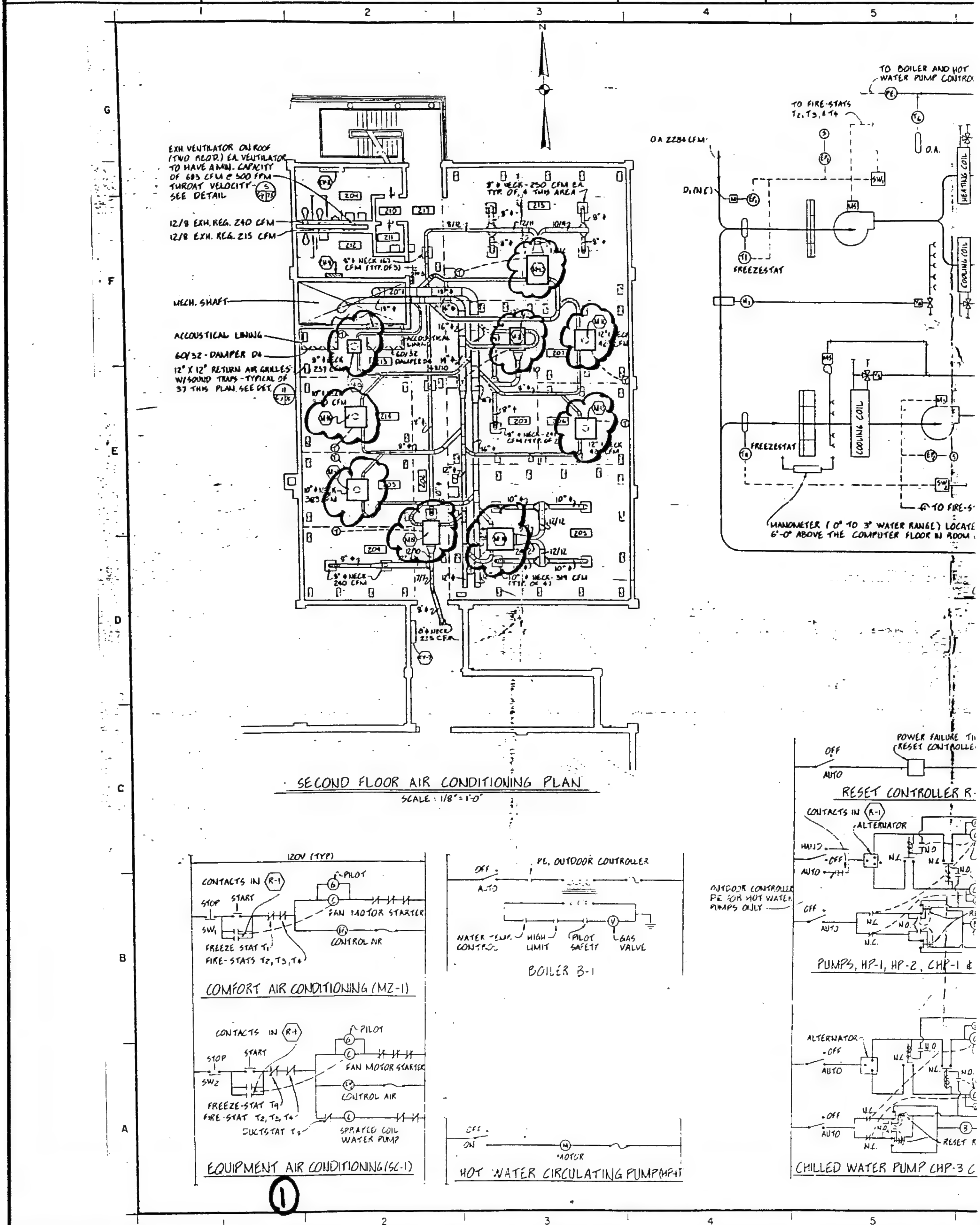
DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.
ENGINEER:

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER EAST ADDITION
VAV RETROFIT
HVAC FIRST FLOOR PLAN

SOL. NO. | DATED: 6–1–93
CONTR. NO.
DRAWING NUMBER: M–9
SHEET NO.: 9 of 13
SEQUENCE NO.: 0

3

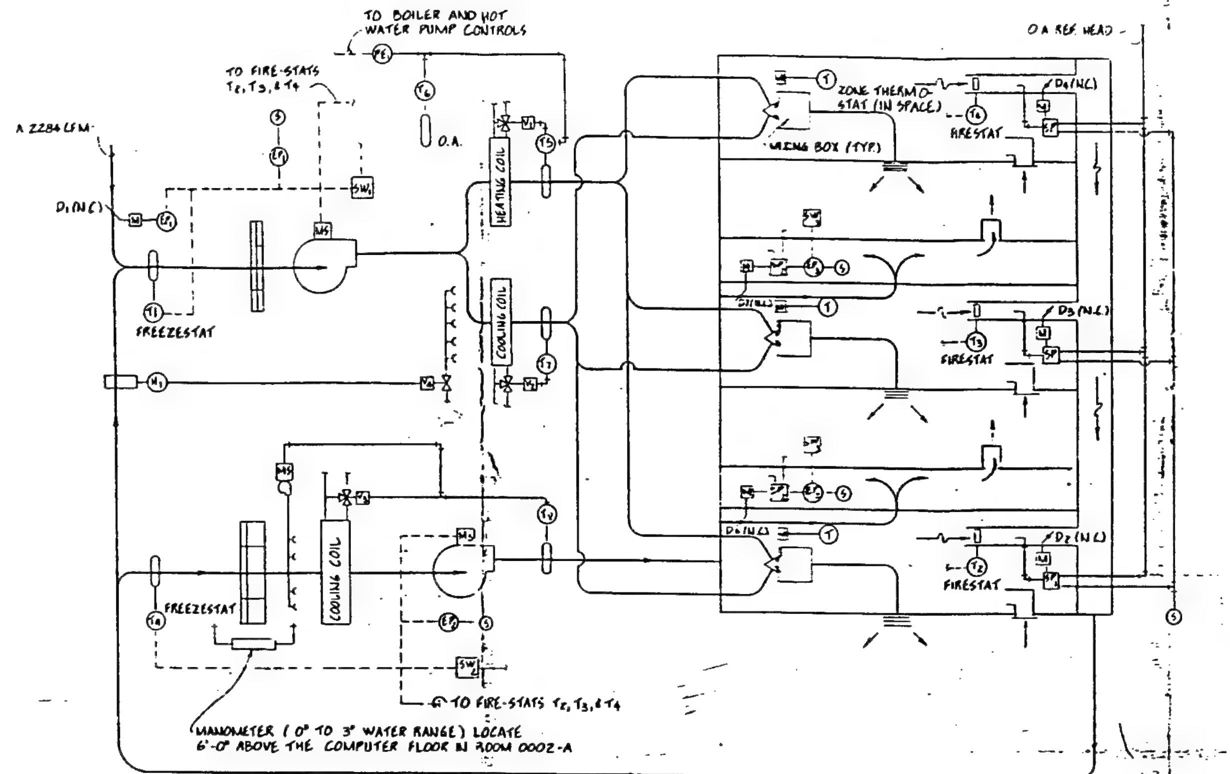
1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Miss



DD FORM 1391c

FOR OFFICIAL USE ONLY

DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldg. 30(



CONTROL DIAGRAM
N.T.S.

CONTROL SEQUEN

COMFORT AIR CONDITIONING (MZ-1)

1. CLOSING SWITCH SW_1 ENERGIZES THE CONTROL CIRCUIT AIR DAMPER D_1 AND STARTS THE FAN.
2. STATIC PRESSURE CONTROLLERS SP_1 (ONE EACH FLOOR) D_4 TO MAINTAIN 0.5 IN. W.G. POSITIVE STATTIC PF RESPECT TO THE OUTSIDE.
3. FREEZE-STAT T_1 WILL OPEN SW_1 IF THE MIXED AIR TE
4. FIRE-STATS T_2, T_3, OR T_4 WILL OPEN SWITCH SW_1 W FROM ANY FLOOR RISES TO 125° F.
5. DUCT-STAT T_5 MODULATES MIXING VALVE V_1 TO MAINTA OUTDOOR CONTROLLER T_6 RESETS HOT DECK CONTROL F TEMPERATURE DROPS. HOT DECK TEMPERATURE SHALL F THE OUTDOOR TEMPERATURE DROPS TO 21° F. AND SHAL TEMPERATURE) WHEN THE OUTDOOR TEMPERATURE RISES
6. DUCT-STAT T_7 MODULATES MIXING VALVE V_2 TO MAINTA AT 49° FDB.
7. ZONE THERMOSTAT "T" MODULATES THE MIXING BOX DA TEMPERATURE AT 72° FDB.
8. HUMIDSTAT H_1 LOCATED IN THE RA STREAM WILL CONTF HOLD A 40% TO 50% RH.

EQUIPMENT AIR CONDITIONING (SC-1)

1. CLOSING SWITCH SW_2 ENERGIZES THE CONTROL CIRCUIT
2. DUCT-STAT T_8 MODULATES MIXING VALVE V_3 TO MAINTA AIR TEMPERATURE AT 52° FDB AND CONTROLS CIRCULA
3. STATIC PRESSURE CONTROLLERS SP_2 (1st & 2nd FLOO TO MAINTAIN 1.0 IN W.G. POSITIVE STATIC PRESSURE RESPECT TO THE SPACE ABOVE THE PLENUM.
4. FREEZE-STAT T_9 OPENS SWITCH SW_2 WHEN THE RETURN 40° FDB.
5. FIRE-STATS T_2, T_3, & T_4 WILL OPEN SWITCH SW_2 WHE FROM ANY FLOOR RISES TO 125° F.
6. SWITCH SW_3 (ONE EACH FLOOR) INTERRUPTS THE CONTF CLOSING THE DAMPER AND CUTTING OFF THE FLOOR PLE FAN SHALL STOP WHEN DAMPERS D_6 & D_7 ARE CLOSED A DAMPER IS OPEN. SWITCH SW_3 SHALL BE LOCATED AS

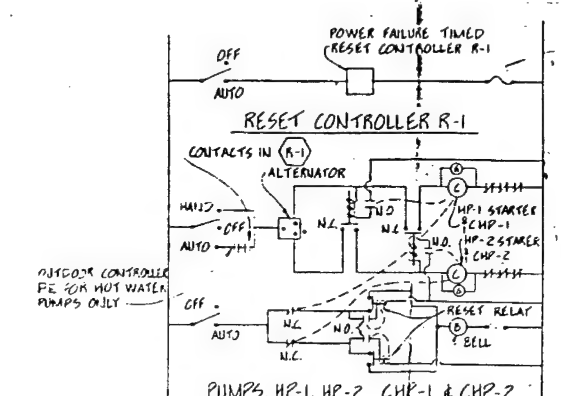
1st FLOOR	ROOM 105
2nd FLOOR	ROOM 202

CHILLERS CH-1 AND CH-2

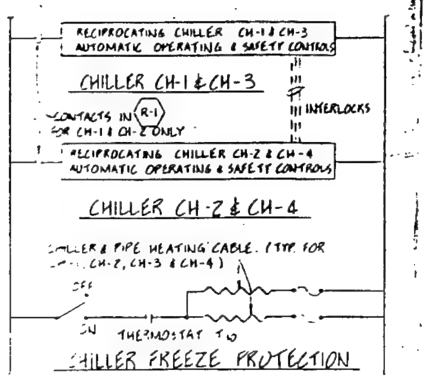
1. CHILLERS SHALL BE SEQUENCED AS THE COOLING LOAD BY SENSORS IN THE CHILLED WATER RETURN OF AS REC
2. SEQUENCE SHALL BE MANUALLY REVERSIBLE.
3. FLOW SWITCHES IN THE CHILLED WATER LINE SHALL PF WHEN CHILLED WATER PUMP IS OFF.

CHILLERS CH-3 AND CH-4

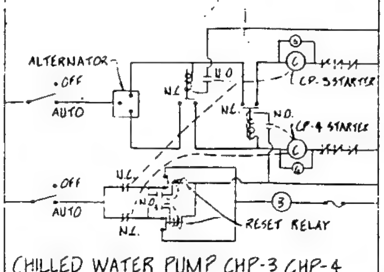
1. CHILLER SHALL BE ENERGIZED MANUALLY BY A HAND OF LOCATED IN THE MECHANICAL ROOM OF THE NEW ADDITI
2. CHILLERS SHALL OPERATE SAME AS CHILLERS CH-1 & C



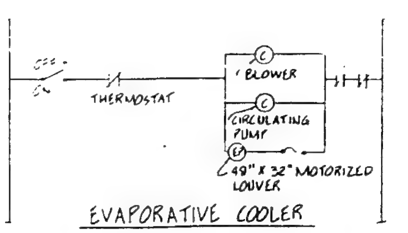
PUMPS, HP-1, HP-2, CHP-1 & CHP-2



CHILLER FREEZE PROTECTION



CHILLED WATER PUMP CHP-3 CHP-4



EVAPORATIVE COOLER

NOTES:

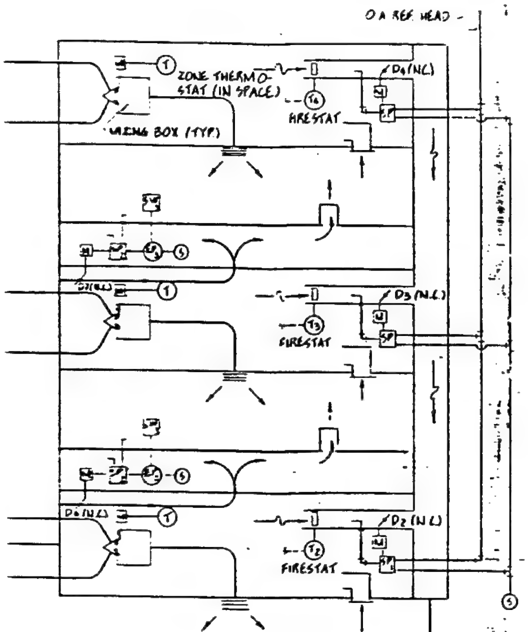
1. THIS DRAWING SHOWS LOCATIONS OF THE
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOX
2. DRAWING NOTES AND LOCATIONS OF WORK ECIP PROJECT ARE INDICATED BY HEAVY L
3. DETAILS PER DRAWING M-11 APPLY TO AL DUAL-DUCT MIXING BOX LOCATIONS.

PLANNING DC

E M C ENGINEERS INC. 2750 S WADSWORTH DENVER, COLORADO DENVER ATLANTA	U.S. A
DESIGNED BY: C.H.B.	WHITE SANDS MISSILE
DRAWN BY: M.D.C.	ECIP HVAC/LIGHTING U RANGE CONTROL CE
REVIEWED BY: D.L.D.	VAV- RE HVAC SECOND
SUBMITTED BY: A.J.N.	SOL. NO.
ENGINEER:	CONTR. NO.
	DRAWING N M

2

4. PROJECT TITLE	5. PROJECT NUMBER
e, NM | ECIP HVAC/Lighting Upgrade – Bldg. 300	



RAM

CONTROL SEQUENCE

COMFORT AIR CONDITIONING (MZ-1)

1. CLOSING SWITCH SW_1 ENERGIZES THE CONTROL CIRCUIT THRU EP_1 OPENING OUTSIDE AIR DAMPER D_1 AND STARTS THE FAN.
2. STATIC PRESSURE CONTROLLERS SP_1 (ONE EACH FLOOR) MODULATE DAMPERS D_2, D_3 & D_4 TO MAINTAIN 0.5 IN. W.G. POSITIVE STATTIC PRESSURE IN THE SPACE WITH RESPECT TO THE OUTSIDE.
3. FREEZE-STAT T_1 WILL OPEN SW_1 IF THE MIXED AIR TEMPERATURE DROPS BELOW 40° F.
4. FIRE-STATS T_2, T_3, OR T_4 WILL OPEN SWITCH SW_1 WHEN THE RETURN AIR TEMPERATURE FROM ANY FLOOR RISES TO 125° F.
5. DUCT-STAT T_5 MODULATES MIXING VALVE V_1 TO MAINTAIN HOT DECK TEMPERATURE. OUTDOOR CONTROLLER T_6 RESETS HOT DECK CONTROL POINT UP AS THE OUTDOOR TEMPERATURE DROPS. HOT DECK TEMPERATURE SHALL REACH MAXIMUM (114° F.) WHEN THE OUTDOOR TEMPERATURE DROPS TO 21° F. AND SHALL BE MINIMUM (MIXED AIR TEMPERATURE) WHEN THE OUTDOOR TEMPERATURE RISES TO 65° F.
6. DUCT-STAT T_7 MODULATES MIXING VALVE V_2 TO MAINTAIN THE COLD DECK TEMPERATURE AT 49° FDB.
7. ZONE THERMOSTAT "T" MODULATES THE MIXING BOX DAMPERS TO MAINTAIN SPACE TEMPERATURE AT 72° FDB.
8. HUMIDSTAT H_1 LOCATED IN THE RA STREAM WILL CONTROL TWO POSITION VALVE V_4 TO HOLD A 40% TO 50% RH.

EQUIPMENT AIR CONDITIONING (SC-1)

1. CLOSING SWITCH SW_2 ENERGIZES THE CONTROL CIRCUIT THRU EP_2 AND STARTS THE FAN.
2. DUCT-STAT T_8 MODULATES MIXING VALVE V_3 TO MAINTAIN THE FLOOR PLENUM ENTERING AIR TEMPERATURE AT 52° FDB AND CONTROLS CIRCULATING PUMP IN AN ON-OFF MANNER.
3. STATIC PRESSURE CONTROLLERS SP_2 (1st & 2nd FLOOR) MODULATE DAMPER D_6 & D_7 TO MAINTAIN 1.0 IN W.G. POSITIVE STATIC PRESSURE IN THE FLOOR PLENUM WITH RESPECT TO THE SPACE ABOVE THE PLENUM.
4. FREEZE-STAT T_9 OPENS SWITCH SW_2 WHEN THE RETURN AIR TEMPERATURE DROPS TO 40° FDB.
5. FIRE-STATS T_2, T_3, & T_4 WILL OPEN SWITCH SW_2 WHEN THE RETURN AIR TEMPERATURE FROM ANY FLOOR RISES TO 125° F.
6. SWITCH SW_3 (ONE EACH FLOOR) INTERRUPTS THE CONTROL AIR TO DAMPERS D_6 & D_7 CLOSING THE DAMPER AND CUTTING OFF THE FLOOR PLENUM AIR TO THAT FLOOR. THE FAN SHALL STOP WHEN DAMPERS D_6 & D_7 ARE CLOSED AND SHALL START WHEN ANY DAMPER IS OPEN. SWITCH SW_3 SHALL BE LOCATED AS FOLLOWS:

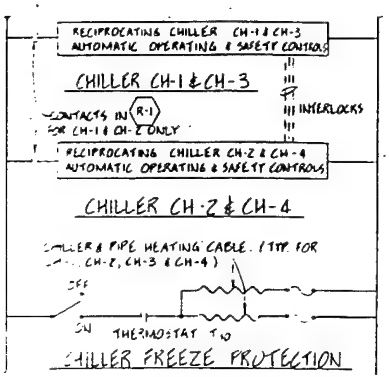
1st FLOOR	ROOM 105
2nd FLOOR	ROOM 202

CHILLERS CH-1 AND CH-2

1. CHILLERS SHALL BE SEQUENCED AS THE COOLING LOAD INCREASES (OR DECREASES) BY SENSORS IN THE CHILLED WATER RETURN OR AS RECOMMENDED BY THE MANUFACTURER.
2. SEQUENCE SHALL BE MANUALLY REVERSIBLE.
3. FLOW SWITCHES IN THE CHILLED WATER LINE SHALL PREVENT CHILLERS FROM RUNNING WHEN CHILLED WATER PUMP IS OFF.

CHILLERS CH-3 AND CH-4

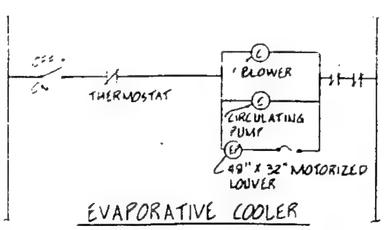
1. CHILLER SHALL BE ENERGIZED MANUALLY BY A HAND OFF AUTOMATIC SWITCH TO BE LOCATED IN THE MECHANICAL ROOM OF THE NEW ADDITION.
2. CHILLERS SHALL OPERATE SAME AS CHILLERS CH-1 & CH-2.



NOTES:

1. THIS DRAWING SHOWS LOCATIONS OF THE:
   - DUAL DUCT MIXING BOXES TO BE REPLACED WITH DUAL DUCT VAV BOXES.
2. DRAWING NOTES AND LOCATIONS OF WORK FOR THE ECIP PROJECT ARE INDICATED BY HEAVY LINE CLOUDING.
3. DETAILS PER DRAWING M-11 APPLY TO ALL EXISTING DUAL-DUCT MIXING BOX LOCATIONS.

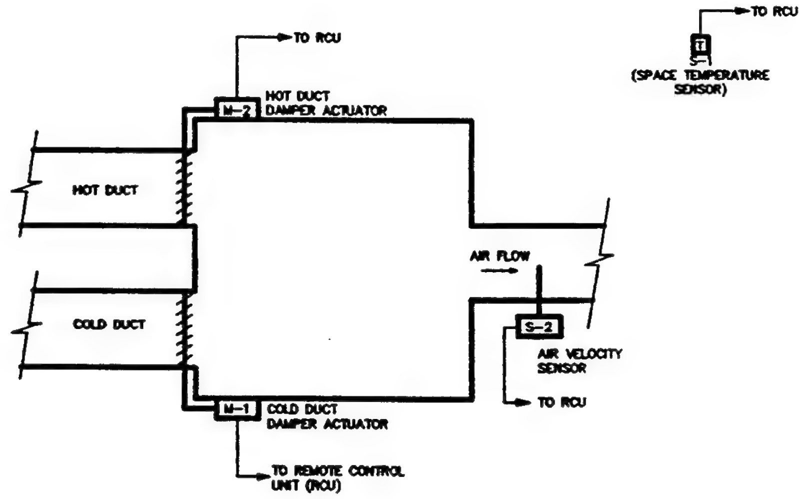
PLANNING DOCUMENT



(3)

E M C ENGINEERS INC. 2750 S WADSWORTH DENVER, COLORADO · DENVER ATLANTA	U.S. ARMY ENGINEER DISTRICT, FORT WORTH · CORPS OF ENGINEERS · FORT WORTH, TEXAS
DESIGNED BY: C.H.B. · DRAWN BY: M.D.C. · REVIEWED BY: D.L.D.	WHITE SANDS MISSILE RANGE, NEW MEXICO · ECIP HVAC/LIGHTING UPGRADE–BUILDING 300 · RANGE CONTROL CENTER EAST ADDITION · VAV-RETROFIT · HVAC SECOND FLOOR PLAN
SUBMITTED BY: A.J.N. · ENGINEER:	SOL. NO. · CONTR. NO. · DATED: 6-1-93 · DRAWING NUMBER M-10 · SHEET NO. 10 OF 13 · SEQUENCE NO. 10

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AN White Sands Mi



DUAL DUCT VAV BOX CONTROL SCHEMATIC
NOT TO SCALE

SEQUENCE OF OPERATION:

VARIABLE AIR VOLUME (VAV) BOXES WITH HOT AND COLD INLET AIR DAMPERS SHALL BE CONTROLLED BY CONTROLLERS:

- TO PROVIDE THE FOLLOWING SEQUENCE OF OPERATION,
- TO PROVIDE THE ASSOCIATED CONSTRAINTS AND INTERLOCKS AS SHOWN,
- ALL CONTROL FUNCTIONS BEING RESIDENT AND EXECUTING IN BOTH THE COMMUNICATING AND NON-COMMUNICATING MODES.

OCCUPIED MODE: UPON INDEXING TO OCCUPIED MODE, THE CONTROLLER SHALL MODULATE THE VAV BOX DAMPERS (M-1 AND M-2) TO MAINTAIN THE AIR VELOCITY (S-2) AT THE VELOCITY SETPOINT, WHICH SHALL BE RESET BY SPACE TEMPERATURE SENSOR (S-1) TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. CONTROL SHALL BE AS FOLLOWS:

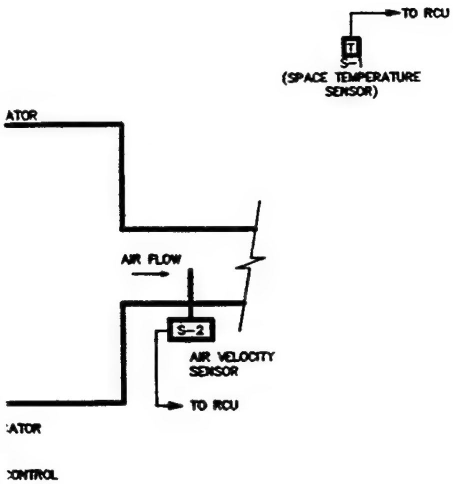
COOLING MODE: ON AN INCREASE IN SPACE TEMPERATURE ABOVE THE COOLING SETPOINT, 78 DEGREES F (ADJUSTABLE), THE CONTROLLER SHALL MODULATE THE COLD DUCT DAMPER ACTUATOR (M-1) TOWARDS OPEN TO MAINTAIN THE OCCUPIED COOLING SETPOINT, 78 DEGREES F (ADJUSTABLE). ON A FURTHER INCREASE IN SPACE TEMPERATURE, THE CONTROLLER SHALL RESET THE VELOCITY SETPOINT (S-2) UPWARD TO MAINTAIN THE OCCUPIED COOLING SETPOINT. ON A DECREASE IN SPACE TEMPERATURE BELOW THE OCCUPIED COOLING SETPOINT, THE CONTROLLER SHALL RESET THE VELOCITY SETPOINT (S-2) DOWNWARD, TO MAINTAIN THE OCCUPIED COOLING SETPOINT. THE HOT DUCT DAMPER ACTUATOR (M-2) SHALL BE IN THE CLOSED POSITION.

HEATING/
DEADBAND MODE: ON A DECREASE IN SPACE TEMPERATURE BELOW 68 DEGREES F (ADJUSTABLE), THE CONTROLLER SHALL MODULATE THE HOT DUCT DAMPER ACTUATOR (M-2) TOWARDS OPEN TO MAINTAIN THE OCCUPIED HEATING SETPOINT, 68 DEGREES F (ADJUSTABLE). ON A FURTHER DECREASE IN SPACE TEMPERATURE, THE CONTROLLER SHALL RESET THE VELOCITY SETPOINT UPWARD TO MAINTAIN THE OCCUPIED HEATING SETPOINT. ON AN INCREASE IN SPACE TEMPERATURE ABOVE THE OCCUPIED HEATING SETPOINT, THE SEQUENCE SHALL BE REVERSED TO MAINTAIN THE OCCUPIED HEATING SETPOINT. THE COLD DUCT DAMPER ACTUATOR (M-1) SHALL BE IN THE CLOSED POSITION.

UNOCCUPIED MODE: UPON INDEXING TO UNOCCUPIED MODE, THE CONTROLLER SHALL DRIVE THE VAV BOX DAMPERS (M-1 AND M-2) TO THE CLOSED POSTIONS. ON A DECREASE IN SPACE TEMPERATURE BELOW 53 DEGREES F (ADJUSTABLE), THE CONTROLLER SHALL DRIVE THE HOT DUCT DAMPER ACTUATOR (M-2) TOWARDS OPEN AND MODULATE M-2 TO MAINTAIN THE UNOCCUPIED HEATING TEMPERATURE SETPOINT, 55 DEGREES F (ADJUSTABLE). UPON INCREASE IN SPACE TEMPERATURE ABOVE 87 DEGREES F (ADJUSTABLE), THE CONTROLLER SHALL DRIVE THE COLD DUCT DAMPER ACTUATOR (M-1) TOWARDS OPEN AND MODULATE M-1 TO MAINTAIN THE UNOCCUPIED COOLING TEMPERATURE SETPOINT, 85 DEGREES F (ADJUSTABLE).

WARMUP AND COOL-DOWN CONTROL: THE CONTROLLER SHALL OPERATE IN THE OCCUPIED MODE DURING WARMUP AND COOL-DOWN PERIODS. COOLING TEMPERATURE SETPOINT DURING COOL-DOWN SHALL BE 65 DEGREES F (ADJUSTABLE).

2. DATE	3. INSTALLATION AND LOCATION	4. PROJECT TITLE
3 AUG 93	White Sands Missile Range, NM	ECIP HVAC/Lighting Upgrade – Bldg.



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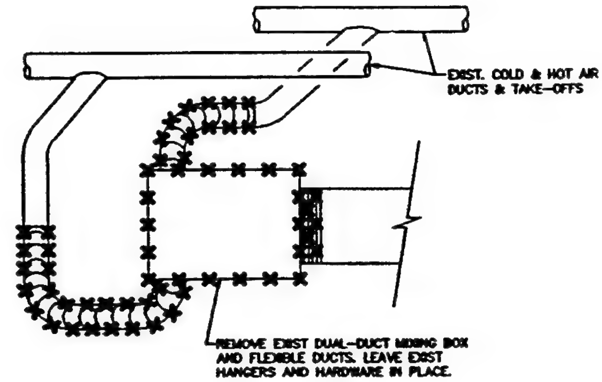
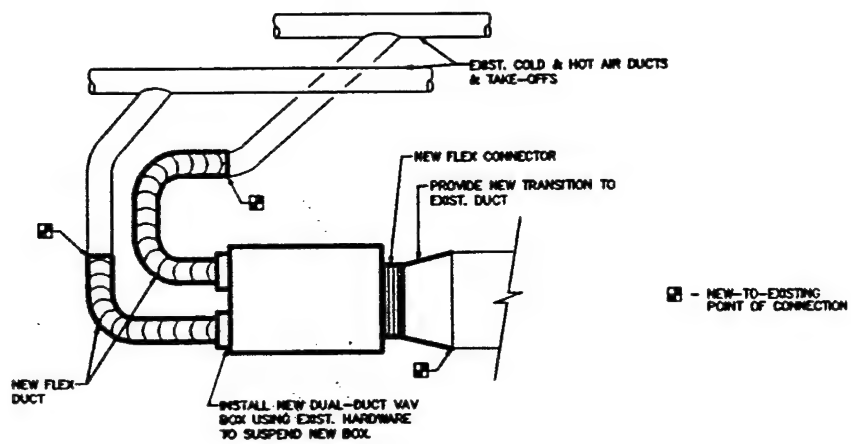


EXISTING MIXING BOX DEMOLITION DETAIL:
NOT TO SCALE



NOTE: DUCTWORK CHANGES WILL BE REQUIRED TO ADAPT TO THE NEW VAV BOX CONFIGURATION.

DUAL DUCT VAV BOX DETAIL:
NOT TO SCALE

ERS SHALL BE CONTROLLED BY CONTROLLERS:

XS AS SHOWN,

IN BOTH THE COMMUNICATING AND NON-COMMUNICATING

OLLER SHALL MODULATE THE VAV BOX DAMPERS (M-1
Y SETPOINT, WHICH SHALL BE RESET BY SPACE
JRE SETPOINT. CONTROL SHALL BE AS FOLLOWS:

)VE THE COOLING SETPOINT, 78 DEGREES F (ADJUSTABLE),
DUCT DAMPER ACTUATOR (M-1) TOWARDS OPEN TO MAINTAIN
S F (ADJUSTABLE). ON A FURTHER INCREASE IN SPACE
THE VELOCITY SETPOINT (S-2) UPWARD TO MAINTAIN THE
IN SPACE TEMPERATURE BELOW THE OCCUPIED COOLING
VELOCITY SETPOINT (S-2) DOWNWARD, TO MAINTAIN THE
DAMPER ACTUATOR (M-2) SHALL BE IN THE CLOSED POSITION.

)W 68 DEGREES F (ADJUSTABLE), THE CONTROLLER SHALL
(M-2) TOWARDS OPEN TO MAINTAIN THE OCCUPIED HEATING
A FURTHER DECREASE IN SPACE TEMPERATURE, THE
OINT UPWARD TO MAINTAIN THE OCCUPIED HEATING SETPOINT.
)VE THE OCCUPIED HEATING SETPOINT, THE SEQUENCE SHALL
ATING SETPOINT. THE COLD DUCT DAMPER ACTUATOR (M-1)

CONTROLLER SHALL DRIVE THE VAV BOX DAMPERS (M-1
E TEMPERATURE BELOW 53 DEGREES F (ADJUSTABLE),
(M-2) TOWARDS OPEN AND MODULATE M-2 TO MAINTAIN THE
JUSTABLE). UPON INCREASE IN SPACE TEMPERATURE
VE THE COLD DUCT DAMPER ACTUATOR (M-1) TOWARDS
3 TEMPERATURE SETPOINT, 85 DEGREES F (ADJUSTABLE).

ERATE IN THE OCCUPIED MODE DURING WARMUP AND COOL-
DOWN SHALL BE 65 DEGREES F (ADJUSTABLE).

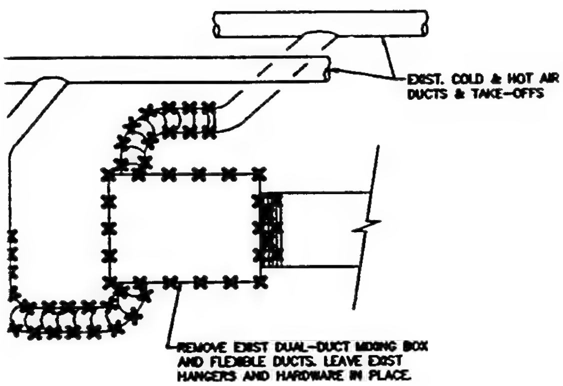
PLANNIN(

DESIGNED BY: C.H.B
DRAWN BY: M.D.C.
CHECKED BY: D.L.D.
SUBMITTED BY: A.J.N.

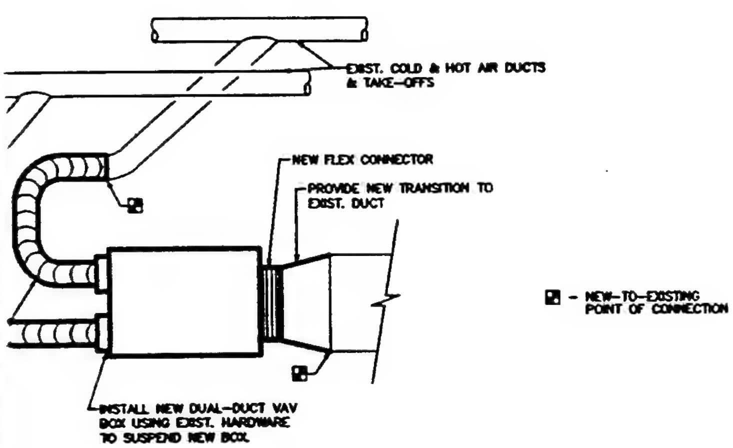
WHITE SAND
ECIP HVAC/L
RANC
DU.
CON

(2)

	4. PROJECT TITLE	5. PROJECT NUMBER
NM	ECIP HVAC/Lighting Upgrade – Bldg. 300	



EXISTING MIXING BOX DEMOLITION DETAIL:
NOT TO SCALE



NOTE: DUCTWORK CHANGES WILL BE REQUIRED TO ADAPT TO THE NEW VAV BOX CONFIGURATION.

DUAL DUCT VAV BOX DETAIL:
NOT TO SCALE

PLANNING DOCUMENT

E M C ENGINEERS INC.
DENVER, COLORADO
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

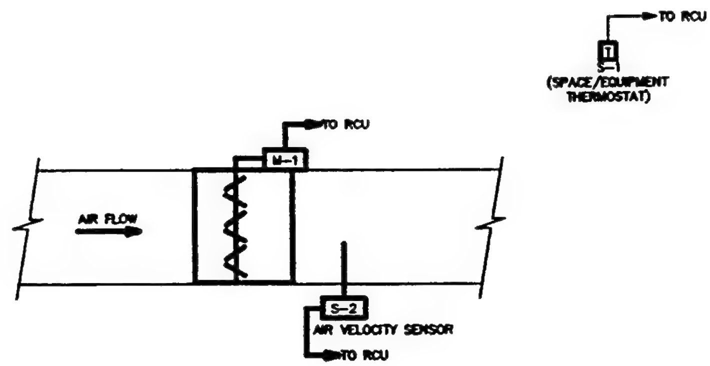
DESIGNED BY: C.H.B
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER
DUAL DUCT VAV BOX
CONTROLS AND DETAILS

DATED: 6-1-93
DRAWING NUMBER: M-11
SHEET NO. 11 of 13
NO. 11

3

1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION ANE White Sands Mis



VAV TERMINAL UNIT CONTROL SCHEMATIC
NOT TO SCALE

SEQUENCE OF OPERATION:

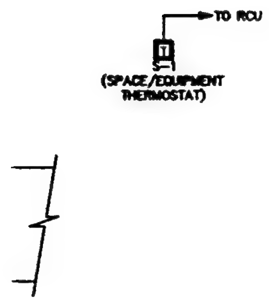
VARIABLE AIR VOLUME (VAV) TERMINAL UNITS WITH DAMPERS SHALL BE CONTROLLED BY CONTROLLERS:

- TO PROVIDE THE FOLLOWING SEQUENCE OF OPERATION,
- TO PROVIDE THE ASSOCIATED CONSTRAINTS AND INTERLOCKS AS SHOWN,
- ALL CONTROL FUNCTIONS BEING RESIDENT AND EXECUTING IN BOTH THE COMMUNICATING AND NON-COMMUNICATING MODES.

OPERATING MODE: UPON INDEXING TO OPERATING MODE, THE CONTROLLER SHALL MODULATE THE VAV TERMINAL UNIT DAMPER (M-1) TO MAINTAIN THE AIR VELOCITY (S-2) AT THE VELOCITY SETPOINT, WHICH SHALL BE RESET BY SPACE TEMPERATURE (S-1) TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. CONTROL SHALL BE AS FOLLOWS:

COOLING MODE: ON AN INCREASE IN SPACE TEMPERATURE ABOVE THE COOLING SETPOINT, 78 DEGREES F (ADJUSTABLE), THE CONTROLLER SHALL RESET THE VELOCITY SETPOINT (S-2) UPWARD TO MAINTAIN THE OCCUPIED COOLING SETPOINT. ON A DECREASE IN SPACE TEMPERATURE BELOW THE OCCUPIED COOLING SETPOINT, THE CONTROLLER SHALL RESET THE VELOCITY SETPOINT (S-2) DOWNWARD, TO MAINTAIN THE OCCUPIED COOLING SETPOINT.

NON-OPERATING MODE: UPON INDEXING TO NON-OPERATING MODE, THE CONTROLLER SHALL DRIVE THE VAV TERMINAL UNIT DAMPER (M-1) TO THE CLOSED POSITION.



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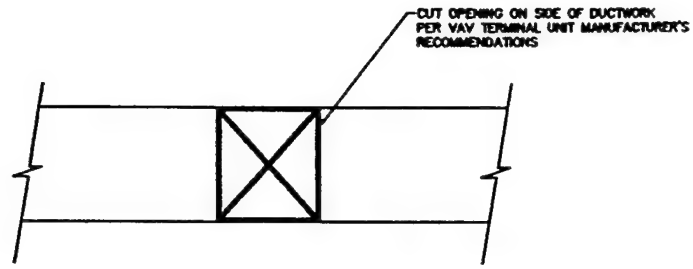


EXISTING SINGLE ZONE DUCTWORK DEMOLITION DETAIL
NOT TO SCALE

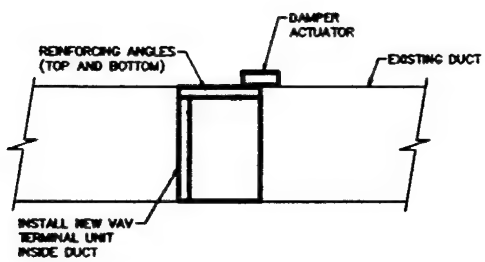
OLLERS:

ICATING AND NON-COMMUNICATING

ATE THE VAV TERMINAL UNIT
H SHALL BE RESET BY SPACE
. BE AS FOLLOWS:

'OINT, 78 DEGREES F (ADJUSTABLE),
RD TO MAINTAIN THE OCCUPIED
' THE OCCUPIED COOLING SETPOINT,
WARD, TO MAINTAIN THE OCCUPIED

HALL DRIVE THE VAV TERMINAL UNIT



SINGLE ZONE VAV TERMINAL UNIT DETAIL
NOT TO SCALE

PLANNING DOCUM

E M C ENGINEERS INC.
2750 S WADSWORTH
DENVER, COLORADO
DENVER ATLANTA

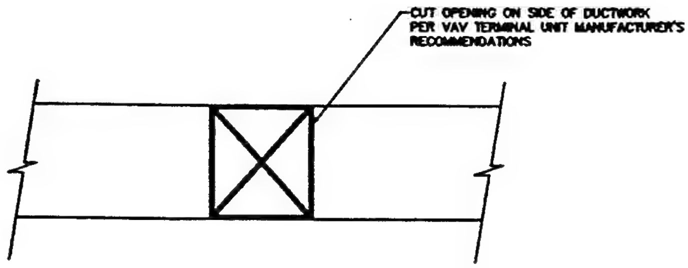
U.S. ARMY ENGINEER
CORPS OF
FORT WO

DESIGNED BY: C.H.B
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.

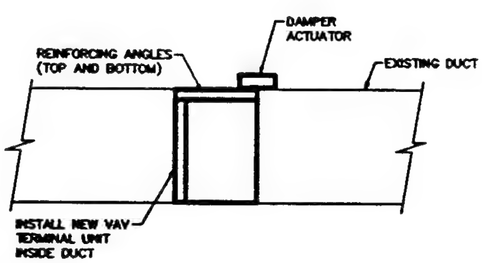
WHITE SANDS MISSILE RANGE, N
ECIP HVAC/LIGHTING UPGRADE–E
RANGE CONTROL CE
SINGLE ZONE VAV TERMI
CONTROLS AND DET

SOL. NO.
CONTR. NO.
DRAWING NUMBER M-12

e, NM	4. PROJECT TITLE ECIP HVAC/Lighting Upgrade – Bldg. 300	5. PROJECT NUMBER



XISTING SINGLE ZONE DUCTWORK DEMOLITION DETAIL
T TO SCALE



SINGLE ZONE VAV TERMINAL UNIT DETAIL
NOT TO SCALE

PLANNING DOCUMENT

E M C ENGINEERS INC.
DENVER, COLORADO
DENVER ATLANTA

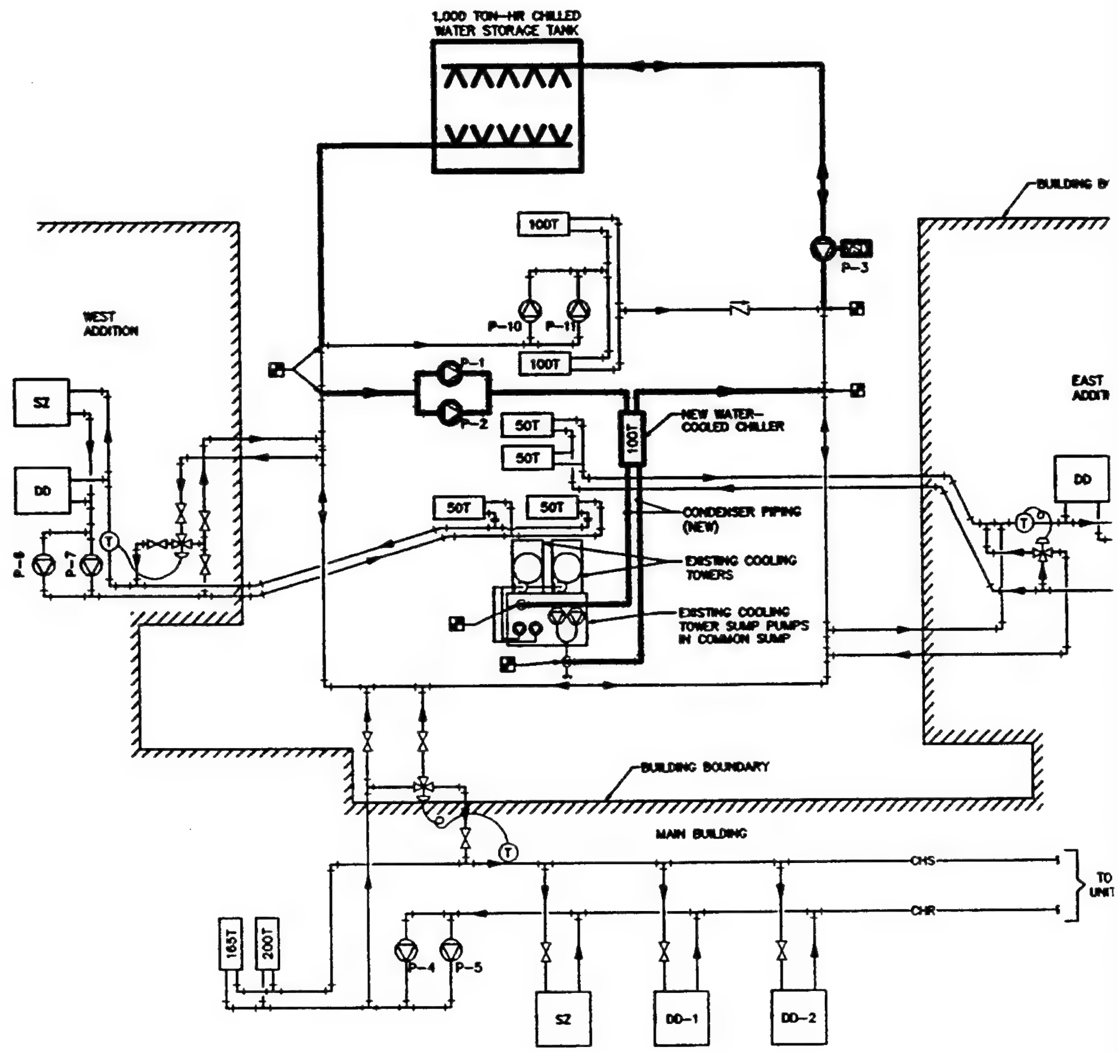
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC/LIGHTING UPGRADE–BUILDING 300
RANGE CONTROL CENTER
SINGLE ZONE VAV TERMINAL UNIT
CONTROLS AND DETAILS

DESIGNED BY: C.H.B
DRAWN BY: M.D.C.
CHECKED BY: D.L.D.
SUBMITTED BY: A.J.N.
SOL. NO.
DATED: 6–1–93
CONTR. NO.
DRAWING NUMBER: M–12
SHEET NO. 12 of 13
SEQUENCE NO. 12

3

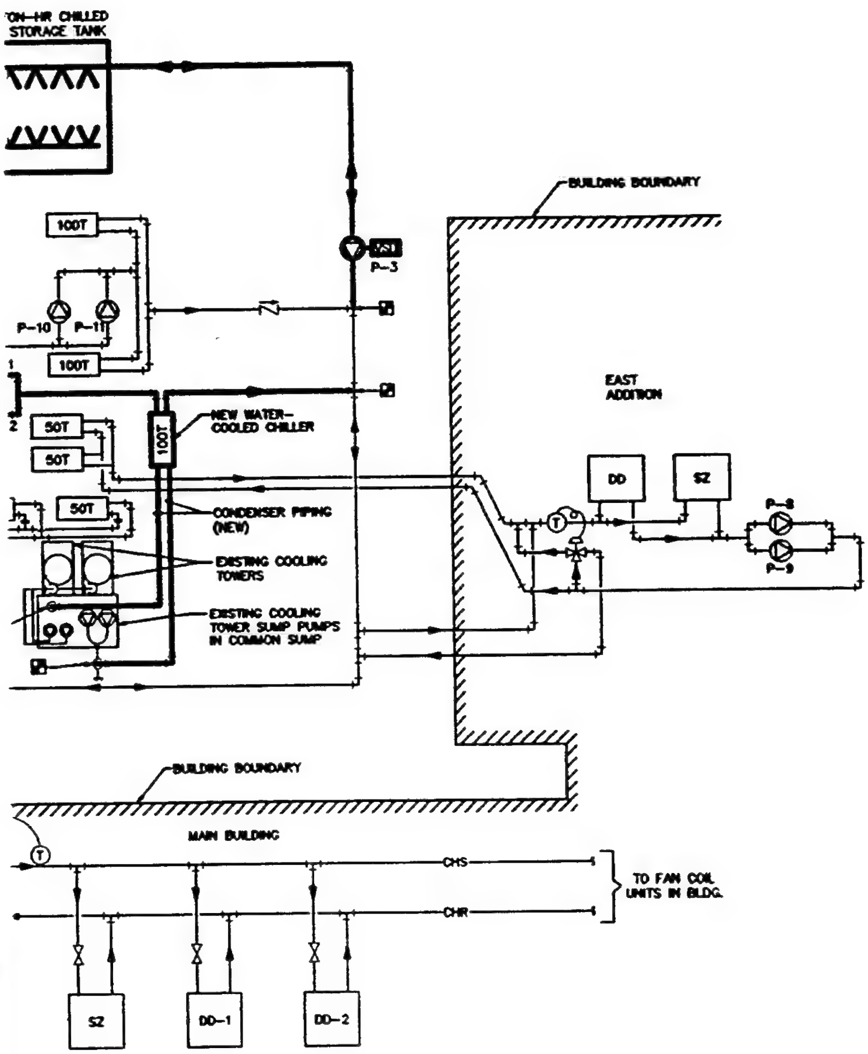
1. COMPONENT ARMY	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 3 AUG 93	3. INSTALLATION AND White Sands Mis



CHILLED WATER THERMAL STORAGE AND WATER-COOLED CHILLER PIPING SCHEMATIC
NOT TO SCALE

1

1ON	2. DATE 3 AUG 93	3. INSTALLATION AND LOCATION White Sands Missile Range, NM	4. PROJECT TITLE ECIP HVAC/Lighting Upgrade – E



ER THERMAL STORAGE AND
ED CHILLER PIPING SCHEMATIC

SEQUENCE OF OPERATION:

1. NORMAL COOLING MODE – VARIABLE SPEED PUMP P-3 IS OFF, AND P
   OR P-5 ARE CIRCULATING CHILLED WATER THROUGH THE CHILLED WAT
2. STORAGE COOLING MODE – PUMPS P-1 OR P-2 ARE OFF AND PUMP
   FROM THE STORAGE TANK THROUGH THE CHILLED WATER LOOP. PUMPS
   CHILLED WATER THROUGH THE AIR HANDLING UNITS.
3. STORAGE CHARGING MODE – PUMPS P-1 OR P-2, P-3, AND P-4 OR
   THROUGH THE CHILLED WATER STORAGE TANK.

LEGEND:

CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
DD	DUAL DUCT AIR HANDLING UNIT
SZ	SINGLE ZONE AIR HANDLING UNIT
VSD	VARIABLE SPEED DRIVE
T	TON
	NEW-TO-EXISTING POINT OF CONNECTION

NOTES:

1. NEW EQUIPMENT AND PIPING IS SHOWN WITH BOLD LINES.

PLAN

EMC

C.H.B.

ECIP

M.D.C.

D.L.D.

A.J.N.

SEQUENCE OF OPERATION:

1. NORMAL COOLING MODE – VARIABLE SPEED PUMP P–3 IS OFF, AND PUMP P–1 OR P–2 AND P–4 OR P–5 ARE CIRCULATING CHILLED WATER THROUGH THE CHILLED WATER LOOP.
2. STORAGE COOLING MODE – PUMPS P–1 OR P–2 ARE OFF AND PUMP P–3 IS CIRCULATING CHILLED WATER FROM THE STORAGE TANK THROUGH THE CHILLED WATER LOOP. PUMPS P–4 THROUGH P–8 CIRCULATE CHILLED WATER THROUGH THE AIR HANDLING UNITS.
3. STORAGE CHARGING MODE – PUMPS P–1 OR P–2, P–3, AND P–4 OR P–5 CIRCULATE CHILLED WATER THROUGH THE CHILLED WATER STORAGE TANK.

LEGEND:

CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
DD	DUAL DUCT AIR HANDLING UNIT
SZ	SINGLE ZONE AIR HANDLING UNIT
VSD	VARIABLE SPEED DRIVE
T	TON
	NEW-TO-EXISTING POINT OF CONNECTION

NOTES:

1. NEW EQUIPMENT AND PIPING IS SHOWN WITH BOLD LINES.

PLANNING DOCUMENT

EMC ENGINEERS INC.
DENVER ATLANTA

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WHITE SANDS MISSILE RANGE, NEW MEXICO
ECIP HVAC / LIGHTING UPGRADE – BUILDING 300
RANGE CONTROL CENTER

CHILLER AND THERMAL STORAGE
PIPING SCHEMATIC

DESIGNED BY: C.H.B.
DRAWN BY: M.D.C.
REVIEWED BY: D.L.D.
SUBMITTED BY: A.J.N.

SOL. NO. .
DATE: 00/00/00
CONTR. NO. .
DRAWING NUMBER M–13
SHEET NO. 13 of 13
SEQUENCE NO. 13

3

Date: August 1993
Project Number:
Project Title: ECIP HVAC / Lighting Upgrade - Building P-300

PROGRAMMING DOCUMENTATION

Method of Analysis:

The existing air systems are constant volume, and sized for the original design cooling loads for the building. The underfloor supply air registers and transfer ducts that currently supply office spaces would be capped off, and only the existing dual duct air systems (DDs) would supply the offices. This would make more air available to the computer and mission equipment rooms, thereby improving the capability of the single zone units (SZUs) to serve the equipment areas. Both the SZUs and the DDs would be converted to VAV units with variable speed controllers and direct digital controls (DDCs). The DD mixing boxes would be converted to VAV mixing boxes. The proposed modification would reduce fan energy consumption, provide excellent flexibility in coping with future changes, correct the problem of overcooling the offices, and improve the cooling of equipment areas.

The current operational practice is to operate the 200 ton centrifugal chiller most of the year, and to augment the cooling capacity with one or both of the 100 ton air-cooled chillers as needed. Four 50 ton air-cooled chillers are used for standby, and operate occasionally. The air-cooled chillers use more kW/ton for cooling than the centrifugal chiller. The opportunity exists to improve the efficiency of the existing chiller plant by installing more water-cooled equipment. This should reduce electrical energy consumption and peak demand. The improved efficiency would be accomplished by the replacement of one of the two 100 ton air-cooled chillers with a new, 100 ton water-cooled reciprocating or scroll chiller connected in parallel to the existing 200 ton chiller. The existing air-cooled chillers would be retained for backup. The three water-cooled chillers would be served by the two existing cooling towers.

The installation of a chilled water thermal storage system will shift the operation of chillers, cooling towers, and condensate pumps to the off peak period, shifting the peak period electrical demand to the off-peak period would reduce the total amount of peak period electrical demand. The chilled water thermal storage system would provide cooling for the building during the peak periods of electrical demand.

The replacement of standard 40 watt fluorescent lamps and standard ballasts with 34 watt lamps and reduced-wattage ballasts will maintain adequate lighting and reduce the air conditioning load. This will reduce electrical demand and conserve electrical energy.

The TRACE 600 program was used to compare the energy consumption of the existing building configuration verses the modified configuration. The baseline TRACE 600 model was modified to incorporate reduced lighting and VAV systems with variable speed control for the SZUs and DDs. The new water-cooled 100 ton reciprocating chiller and the chilled water thermal storage system were added to the equipment portion of the TRACE 600 program.

Date: August 1993
Project Number:
Project Title: ECIP HVAC / Lighting Upgrade - Building P-300

PROGRAMMING DOCUMENTATION (continued)

The hourly average day per month weather data used in the TRACE 600 program was weather for El Paso, Texas.

Assumptions:

Gas cost = $2.2124/MBtu

Electric cost = $0.0221/kWh

Electric demand cost = $19.50/kW
Electric rebate for shifting on-peak loads to off-peak period = $190.00/kW

Average fluorescent lamp life = 20,000 hours

Average fluorescent ballast life = 60,000 hours

Fluorescent lighting system operating hours = 4,368 hrs/yr

Calculations:

Difference in Building P-300 Energy Consumption (figures taken from TRACE 600 output reports).

Baseline annual kWh - Modified Configuration annual kWh = Annual kWh Savings:

(4,675,776 - 3,285,543) = 1,390,233 kWh.

Baseline annual gas - Modified Configuration annual gas = Annual kWh Savings:

(2,355 - 1,612) = 743 MBtu.

Baseline annual electric demand - (Modified Configuration without thermal storage - Thermal storage annual electric demand) = Annual kWh Savings:

8,840 kW - (6,615 kW - 1,464 kW) = 3,689 kW.

Date: August 1993
Project Number:
Project Title: ECIP HVAC / Lighting Upgrade - Building P-300

PROGRAMMING DOCUMENTATION (continued)

Annual Recurring Maintenance

Cost Savings for the Chiller Plant with thermal storage (increased use of cooling towers) = ($1,000)

Annual Recurring Maintenance Cost Savings for the AHUs = $0

Annual Recurring Maintenance Cost Savings for the modified lighting = $6,060

Maintenance Cost Savings for lamp replacement occur within the first 5 years:
20,000 hours / 4,368 hrs/yr = 4.6 yrs or approx. 5 years (rounded)

Maintenance Cost Savings for ballast replacement occur within the first 15 years:
60,000 hours / 4,368 hrs/yr = 13.7 yrs or approx. 14 years (rounded)

Lamp Replacement per Year:
(4,368 hrs / 20,000 hrs) x 2,545 lamps = 556 lamps

Maintenance Cost Savings for lamp replacement:
Material - 556 lamps x $2.19/lamp = $1,217.64
Labor - 556 lamps x 0.09 hrs/lamp x $27.6/hr = $1,381.10

Ballast Replacement per Year:
(4,368 hrs / 60,000 hrs) x 1,245 ballasts = 91 ballasts
(4,368 hrs / 60,000 hrs) x 18 dimming ballasts = 1 ballasts

Maintenance Cost Savings for ballast replacement:
Material - 91 ballasts x $14.06/ballast = $1,279.46
Material - 1 dimming ballast x $21.75/dimming ballast = $21.75
Labor - 92 ballasts x 0.85 hrs/ballast x $27.6/hr = $2,158.32

Nonrecurring Cost Savings

Nonrecurring Cost Savings occurring in year one = $54,788 Utility Rebate

Utility Rebate Calculation:

Design Load:	East Addition =	39.4 tons
	West Addition =	52.0 tons
	Main Bldg. =	129.0 tons
		320.4 tons

Date: August 1993
Project Number:
Project Title: ECIP HVAC / Lighting Upgrade - Building P-300

PROGRAMMING DOCUMENTATION (continued)

Compressor Load = 0.9 kW/ton x 320.4 tons = 288.4 kW.

Utility Rebate = $190 x 288.4 = $54,788

Economic Analysis:

SUMMARY

Project	Annual Energy Savings (MBtu/yr)	Total Annual Cost Savings ($/yr)	Simple Payback (yrs)	SIR	AIRR %
ECIP HVAC/Lighting Upgrade - Building P-300	5,488	104,325	5.2	2.6	9.2

The Life Cycle Cost Analysis (LCCA) for the ECIP project is presented on the following page. The energy savings shown on the LCCA form take into account interactive effects of all energy conservation measures.

Individual LCCAs for the VAV retrofit, chiller plant replacement, chilled water thermal storage, and modified lighting are included. Each modification qualifies independently for the ECIP program.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: White Sands Missile Range   REGION: 4   PROJECT NO: DACA 63-91-C-0152
PROJECT TITLE: BLDG. 300 - MODIFIED CONFIGURATION   FISCAL YEAR: 1992
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 08/05/93   ECONOMIC LIFE: 20   PREPARED BY: A. Niemeyer

1 INVESTMENT COSTS

A.	CONSTRUCTION COST	=	$524,275	
B.	SIOH COST	(5.5% of 1A) =	$28,835	
C.	DESIGN COST	(6.0% of 1A) =	$31,457	
D.	TOTAL COST	(1A + 1B + 1C) =	$584,567	
E.	SALVAGE VALUE	=	$0	
F.	SALVAGE VALUE OF EXISTING EQUIP.	=	$0	
G.	TOTAL INVESTMENT	(1D - 1E - 1F) =	----------->	$584,567

2 ENERGY SAVINGS (+) or COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: OCTOBER 1992

	ENERGY SOURCE	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELEC	$6.48	4,745	$30,748	14.53	$446,763	
B.	DIST			$0	17.63	$0	
C.	NAT GAS	$2.21	743	$1,642	18.59	$30,525	
D.	COAL		0	$0	14.46	$0	
E.	SOLAR			$0		$0	
F.	DEMAND SAVINGS	($19.50/kW x 3689 kW)		$71,936	13.59	$977,603	
G.	TOTAL		5,488	$104,325		----------->	$1,454,891

3 NONENERGY SAVINGS (+) or COST (-)

A.	ANNUAL RECURRING			$5,060
	1 DISCOUNT FACTOR *	(From Table A-2) =	7.21	
	2 DISCOUNTED SAVINGS or COST	(3A x 3A1) =		$36,483

* Weighted Discount Factor: $2,600 at 5 yrs. (4.45), $3,460 at 15 yrs. (11.12), and $-1,000 at 20 yrs. (13.59)
[($2,600 x 4.45) + ($3,460 x 11.12) + ($-1,000 x 13.59)] / $5,060 = 7.205

B. NONRECURRING

ITEM	SAVINGS or COST (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3)	DISCOUNTED SVGS or COST (4)
a. Utility rebate	$54,788	1	0.96	$52,596
b.	$0	0	0.00	$0
c.	$0	0	0.00	$0
d TOTAL	$54,788			$52,596

C. TOTAL NONENERGY DISCOUNTED SAVINGS or COST (3A2 + 3Bd4) = $89,079

4 SIMPLE PAYBACK (SPB) - (YRS)	1G/(2G3 + 3A + (3Bd1/20)) =	5.2
5 TOTAL NET DISCOUNTED SAVINGS	(2G5 + 3C) =	$1,543,970
6 SAVINGS-TO-INVESTMENT RATIO (SIR)	(5/1G) =	2.64
7 ADJUSTED INTERNAL RATE OF RETURN (AIRR) - (%)	[(1+.04) x SIR to 1/20 power - 1] x 100 =	9.18

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: White Sands Missile Range REGION: 4 PROJECT NO: DACA 63-91-C-0152
PROJECT TITLE: BLDG. 300 - MODIFIED CONFIGURATION W/O VARIABLE AIR VOLUMEFISCAL YEAR: 1992
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 06/17/93 ECONOMIC LIFE: 20 PREPARED BY: A. Niemeyer

1 INVESTMENT COSTS

A.	CONSTRUCTION COST	=	$309,566	
B.	SIOH COST	(5.5% of 1A) =	$17,026	
C.	DESIGN COST	(6.0% of 1A) =	$18,574	
D.	TOTAL COST	(1A + 1B + 1C) =	$345,166	
E.	SALVAGE VALUE	=	$0	
F.	SALVAGE VALUE OF EXISTING EQUIP.	=	$0	
G.	TOTAL INVESTMENT	(1D - 1E - 1F) =	---------->	$345,166

2 ENERGY SAVINGS (+) or COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: OCTOBER 1992

	ENERGY SOURCE	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELEC	$6.48	3,940	$25,534	14.53	$371,010	
B.	DIST			$0	17.63	$0	
C.	NAT GAS	$2.21	761	$1,682	18.59	$31,265	
D.	COAL		0	$0	14.46	$0	
E.	SOLAR			$0		$0	
F.	DEMAND SAVINGS	($19.50/kW x 889 kW)		$17,336	13.59	$235,589	
G.	TOTAL		4,701	$44,551		---------->	$637,864

3 NONENERGY SAVINGS (+) or COST (-)

A. ANNUAL RECURRING

1 DISCOUNT FACTOR	(From Table A-2) =	13.59		
2 DISCOUNTED SAVINGS or COST	(3A x 3A1) =		$0	

B. NONRECURRING

ITEM	SAVINGS or COST (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3)	DISCOUNTED SVGS or COST (4)	
a.	$0	0	0.00	$0	
b.	$0	0	0.00	$0	
c.	$0	0	0.00	$0	
d TOTAL	$0			$0	

C. TOTAL NONENERGY DISCOUNTED SAVINGS or COST (3A2 + 3Bd4) = $0

4 SIMPLE PAYBACK (SPB) - (YRS)	1G/(2G3 + 3A + (3Bd1/20)) =	7.7
5 TOTAL NET DISCOUNTED SAVINGS	(2G5 + 3C) =	$637,864
6 SAVINGS-TO-INVESTMENT RATIO (SIR)	(5/1G) =	1.85
7 ADJUSTED INTERNAL RATE OF RETURN (AIRR) - (%)	[(1+.04) x SIR to 1/20 power - 1] x 100 =	7.24

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: White Sands Missile Range   REGION: 4   PROJECT NO: DACA 63-91-C-0152

PROJECT TITLE: BLDG. 300 - MODIFIED CONFIGURATION W/O CONS. CHILLER PLANT FISCAL YEAR: 1992

DISCRETE PORTION NAME: TOTAL

ANALYSIS DATE: 06/17/93   ECONOMIC LIFE: 20   PREPARED BY: A. Niemeyer

1 INVESTMENT COSTS

A.	CONSTRUCTION COST	=	$72,893	
B.	SIOH COST	(5.5% of 1A) =	$4,009	
C.	DESIGN COST	(6.0% of 1A) =	$4,374	
D.	TOTAL COST	(1A + 1B + 1C) =	$81,276	
E.	SALVAGE VALUE	=	$0	
F.	SALVAGE VALUE OF EXISTING EQUIP.	=	$0	
G.	TOTAL INVESTMENT	(1D - 1E - 1F) =	---------->	$81,276

2 ENERGY SAVINGS (+) or COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: OCTOBER 1992

	ENERGY SOURCE	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELEC	$6.48	617	$3,998	14.53	$58,087	
B.	DIST			$0	17.63	$0	
C.	NAT GAS	$2.21	0	$0	18.59	$0	
D.	COAL		0	$0	14.46	$0	
E.	SOLAR			$0		$0	
F.	DEMAND SAVINGS	($19.50/kW x 216 kW)		$4,212	13.59	$57,241	
G.	TOTAL		617	$8,210		---------->	$115,328

3 NONENERGY SAVINGS (+) or COST (-)

A. ANNUAL RECURRING			($1,000)	
1 DISCOUNT FACTOR	(From Table A-2) =	13.59		
2 DISCOUNTED SAVINGS or COST	(3A x 3A1) =		($13,590)	

B. NONRECURRING

ITEM	SAVINGS or COST (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3)	DISCOUNTED SVGS or COST (4)	
a.	$0	0	0.00	$0	
b.	$0	0	0.00	$0	
c.	$0	0	0.00	$0	
d TOTAL	$0			$0	
C. TOTAL NONENERGY DISCOUNTED SAVINGS or COST			(3A2 + 3Bd4) =		($13,590)

4 SIMPLE PAYBACK (SPB) - (YRS)	1G/(2G3 + 3A + (3Bd1/20)) =	11.3
5 TOTAL NET DISCOUNTED SAVINGS	(2G5 + 3C) =	$101,738
6 SAVINGS-TO-INVESTMENT RATIO (SIR)	(5/1G) =	1.25
7 ADJUSTED INTERNAL RATE OF RETURN (AIRR) - (%)	[(1+.04) x SIR to 1/20 power - 1] x 100 =	5.17

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: White Sands Missile Range REGION: 4 PROJECT NO: DACA 63-91-C-0152
PROJECT TITLE: BLDG. 300 - MODIFIED CONFIGURATION W/O THERMAL STORAGE FISCAL YEAR: 1992
DISCRETE PORTION NAME: TOTAL
ANALYSIS DATE: 06/17/93 ECONOMIC LIFE: 20 PREPARED BY: A. Niemeyer

1 INVESTMENT COSTS

A.	CONSTRUCTION COST	=	$82,500	
B.	SIOH COST	(5.5% of 1A) =	$4,538	
C.	DESIGN COST	(6.0% of 1A) =	$4,950	
D.	TOTAL COST	(1A + 1B + 1C) =	$91,988	
E.	SALVAGE VALUE	=	$0	
F.	SALVAGE VALUE OF EXISTING EQUIP.	=	$0	
G.	TOTAL INVESTMENT	(1D - 1E - 1F) =	---------->	$91,988

2 ENERGY SAVINGS (+) or COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: 13 NOVEMBER 1992

	ENERGY SOURCE	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELEC	$6.48	(21)	($136)	14.53	($1,977)	
B.	DIST			$0	17.63	$0	
C.	NAT GAS	$2.21	0	$0	18.59	$0	
D.	COAL		0	$0	14.46	$0	
E.	SOLAR			$0		$0	
F.	DEMAND SAVINGS	($19.50/kW x 1283 kW)		$25,019	13.59	$340,001	
G.	TOTAL		(21)	$24,882		---------->	$338,024

3 NONENERGY SAVINGS (+) or COST (-)

A. ANNUAL RECURRING

1 DISCOUNT FACTOR	(From Table A-2) =	13.59	
2 DISCOUNTED SAVINGS or COST	(3A x 3A1) =		$0

B. NONRECURRING

ITEM	SAVINGS or COST (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3)	DISCOUNTED SVGS or COST (4)	
a. Utility rebate	$54,788	1	0.96	$52,596	
b.	$0	0	0.00	$0	
c.	$0	0	0.00	$0	
d TOTAL	$54,788			$52,596	
C. TOTAL NONENERGY DISCOUNTED SAVINGS or COST			(3A2 + 3Bd4) =		$52,596

4 SIMPLE PAYBACK (SPB) - (YRS)	1G/(2G3 + 3A + (3Bd1/20)) =	3.3
5 TOTAL NET DISCOUNTED SAVINGS	(2G5 + 3C) =	$390,621
6 SAVINGS-TO-INVESTMENT RATIO (SIR)	(5/1G) =	4.25
7 ADJUSTED INTERNAL RATE OF RETURN (AIRR) - (%)	[(1+.04) x SIR to 1/20 power - 1] x 100 =	11.80

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: White Sands Missile Range REGION: 4 PROJECT NO: DACA 63-91-C-0152

PROJECT TITLE: BLDG. 300 - MODIFIED CONFIGURATION W/O EFFICIENT LIGHTING FISCAL YEAR: 1992

DISCRETE PORTION NAME: TOTAL

ANALYSIS DATE: 05/27/93 ECONOMIC LIFE: 15 PREPARED BY: A. Niemeyer

1 INVESTMENT COSTS

A.	CONSTRUCTION COST	=	$59,316	
B.	SIOH COST	(5.5% of 1A) =	$3,262	
C.	DESIGN COST	(6.0% of 1A) =	$3,559	
D.	TOTAL COST	(1A + 1B + 1C) =	$66,137	
E.	SALVAGE VALUE	=	$0	
F.	SALVAGE VALUE OF EXISTING EQUIP.	=	$0	
G.	TOTAL INVESTMENT	(1D - 1E - 1F) =	---------->	$66,137

2 ENERGY SAVINGS (+) or COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: 13 NOVEMBER 1992

	ENERGY SOURCE	COST $/MBTU (1)	SAVINGS MBTU/YR (2)	ANNUAL $ SAVINGS (3)	DISCOUNT FACTOR (4)	DISCOUNTED SAVINGS (5)	
A.	ELEC	$6.48	77	$499	11.70	$5,837	
B.	DIST			$0	13.78	$0	
C.	NAT GAS	$2.21	(28)	($61)	14.16	($861)	
D.	COAL		0	$0	11.57	$0	
E.	SOLAR			$0		$0	
F.	DEMAND SAVINGS	($19.5/kW x 290 kW)		$5,655	11.12	$62,884	
G.	TOTAL		49	$6,093		---------->	$67,860

3 NONENERGY SAVINGS (+) or COST (-)

A. ANNUAL RECURRING (Maintenance Cost Savings)			$6,060	
1 DISCOUNT FACTOR *	(From Table A-2) =	8.26		
2 DISCOUNTED SAVINGS or COST	(3A x 3A1) =		$50,056	

* Weighted Discount Factor: Lamps - $2,600 at 5 yrs. (4.45) and Ballasts - $3,460 at 15 yrs. (11.12)
[($2,600 x 4.45) + ($3,460 x 11.12)] / $6,060 = 8.258

B. NONRECURRING

ITEM	SAVINGS or COST (1)	YEAR OF OCCURRENCE (2)	DISCOUNT FACTOR (3)	DISCOUNTED SVGS or COST (4)
a.	$0	0	0.00	$0
b.	$0	0	0.00	$0
c.	$0	0	0.00	$0
d TOTAL	$0			$0

C. TOTAL NONENERGY DISCOUNTED SAVINGS or COST (3A2 + 3Bd4) = $50,056

4 SIMPLE PAYBACK (SPB) - (YRS)	1G/(2G3 + 3A + (3Bd1/20)) =	5.4
5 TOTAL NET DISCOUNTED SAVINGS	(2G5 + 3C) =	$117,915
6 SAVINGS-TO-INVESTMENT RATIO (SIR)	(5/1G) =	1.78
7 ADJUSTED INTERNAL RATE OF RETURN (AIRR) - (%)	[(1+.04) x SIR to 1/20 power - 1] x 100 =	8.09

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT White Sands Missile Range ESOS	**INVITATION/CONTRACTOR**	**EFFECTIVE PRICING DATE** June 1993	**DATE PREPARED** June 1993
	CODE *(Check one)* [X] A [ ] B [ ] C	**DRAWING NO.** ECIP HVAC/ Lighting Upgrade-BldgP300	**SHEET** 1 **OF** 3 **SHEETS**
LOCATION White Sands Missile Range, New Mexico	[ ] OTHER	**ESTIMATOR** A. Niemeyer	**CHECKED BY** T. Forster

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	NO. OF UNITS	UNIT MEAS	MH UNIT	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST		UNIT WT	TOTAL WT
Sheet 2 of 3											302,339		
Sheet 3 of 3											112,108		
Subtotal											414,447		
Contractor OH @ 15%											62,167		
Contractor Profit @ 10%											47,661		
Construction Cost											524,275		
TOTAL THIS SHEET													

DA FORM 5418-R, Apr 85

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

INVITATION/CONTRACTOR	
EFFECTIVE PRICING DATE	June 1993
DATE PREPARED	June 1993
PROJECT	White Sands Missile Range ESOS
CODE (Check one)	[X] A [ ] B [ ] C [ ] OTHER
DRAWING NO.	ECIP HVAC/ Lighting Upgrade-BldgP300
SHEET	2 OF 3 SHEETS
LOCATION	White Sands Missile Range, New Mexico
ESTIMATOR	A. Niemeyer
CHECKED BY	T. Forster

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	NO. OF UNITS	UNIT MEAS	MH UNIT	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST		UNIT WT	TOTAL WT
VAV Retrofit Demolition	1	LS				3,040					3,040		
Variable Frequency Drives													
Main Building	3	EA			1210	3,630			12,750	38,250	41,880		
East & West Wings	4	EA			970	3,880			5,507	22,028	25,908		
VAV Mixing Boxes	84	EA			73	6,132			495	41.580	47,712		
VAV Mixing Box Controls	84	EA			314.6	21,600			741	62.241	88,667		
Controls for AHUs	7	EA			631.4	4,420			1,265	8,855	13,275		
Modify Ductwork; Test & Balance	1	EA				20,140				3,358	23,498		
100 Ton Water-Cooled Chiller	1	EA				12,362				45,997	58,359		
TOTAL THIS SHEET											302,339		

DA FORM 5418-R, Apr 85

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

INVITATION/CONTRACTOR	
EFFECTIVE PRICING DATE	June 1993
DATE PREPARED	June 1993
PROJECT	White Sands Missile Range ESOS
LOCATION	White Sands Missile Range, New Mexico
CODE (Check one)	[X] A [ ] B [ ] C [ ] OTHER
DRAWING NO.	ECIP HVAC/ Lighting Upgrade-BldgP30
SHEET	3 OF 3 SHEETS
ESTIMATOR	A. Niemeyer
CHECKED BY	T. Forster

TASK DESCRIPTION	QUANTITY NO. OF UNITS	QUANTITY UNIT MEAS	LABOR MH UNIT	LABOR TOTAL HRS	LABOR UNIT PRICE	LABOR COST	EQUIPMENT UNIT PRICE	EQUIPMENT COST	MATERIAL UNIT PRICE	MATERIAL COST	TOTAL	SHIPPING UNIT WT	SHIPPING TOTAL WT
Install 1,000 ton -hr.	1	LS				65,218					65,218		
Chilled Water thermal													
storage													
Install energy efficient													
lamps and ballasts													
4 ft. efficient lamps	2,545	ea			1.92	4,886			1.73	4,403	9,289		
Efficient ballasts	1,263	ea			18.52	23,392			11.25	14,209	37,601		
TOTAL THIS SHEET											112,108		

DA FORM 5418-R, Apr 85

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 1 (BASELINE - BLDG P300)

MONTHLY ENERGY CONSUMPTION

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	370,311	664	6,458	145	14
Feb	335,056	663	5,227	135	14
March	378,559	692	2,512	182	8
April	374,522	726	585	227	3
May	406,945	754	9	326	0
June	414,722	831	0	382	0
July	433,778	837	0	408	0
Aug	434,746	829	0	398	0
Sept	398,870	757	0	321	0
Oct	394,963	729	782	248	4
Nov	362,831	690	2,815	175	9
Dec	370,472	668	5,163	156	11
Total	4,675,776	837	23,551	3,104	14

Building Energy Consumption = 301,008 (Btu/Sq Ft/Year) **Floor Area = 60,840 (Sq Ft)**
Source Energy Consumption = 302,206 (Btu/Sq Ft/Year)

Σ monthly Kw = 8840

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 1

------------------------------------ M O N T H L Y   E N E R G Y   C O N S U M P T I O N ------------------------------------

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	238,157	509	4,478	47	12
Feb	217,613	510	3,581	48	11
March	255,204	519	1,645	91	6
April	257,655	537	482	130	3
May	296,298	563	95	200	2
June	303,713	569	0	245	0
July	329,134	636	0	293	0
Aug	332,264	622	0	289	0
Sept	295,108	579	33	224	1
Oct	274,872	544	552	145	2
Nov	243,285	517	1,814	85	6
Dec	242,240	510	3,442	60	8
Total	3,285,543	636	16,123	1,857	12

Building Energy Consumption = 210,812 (Btu/Sq Ft/Year)   Floor Area = 60,840 (Sq Ft)
Source Energy Consumption = 211,632 (Btu/Sq Ft/Year)

Σ Monthy. kW = 6615

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 1
MOD CONFIG - BLDG 300 WITHOUT THERM STOR *

----- M O N T H L Y   E N E R G Y   C O N S U M P T I O N -----

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	237,896	514	4,478	47	12
Feb	217,350	518	3,581	48	11
March	254,879	553	1,645	90	6
April	257,323	611	482	129	3
May	295,498	644	95	197	2
June	302,610	666	0	242	0
July	329,801	677	0	293	0
Aug	332,016	675	0	289	0
Sept	293,672	648	33	221	1
Oct	273,498	619	552	143	2
Nov	242,964	550	1,814	84	6
Dec	241,890	520	3,442	60	8
Total	3,279,396	677	16,123	1,843	12

Building Energy Consumption = 210,467 (Btu/Sq Ft/Year)   Floor Area = 60,840 (Sq Ft)
Source Energy Consumption = 211,287 (Btu/Sq Ft/Year)

* ALSO USED FOR THE BASELINE CONSUMPTION TO EVALUATE THE INTERACTION EFFECTS OF VAV, LIGHTING AND CONSOLIDATED CHILLER PLANT ECOs.

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 2
MOD CONFIG - BLDG 300 WITHOUT VAV

------------------------------------ M O N T H L Y   E N E R G Y   C O N S U M P T I O N ------------------------------------

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	351,780	626	6,514	137	14
Feb	318,420	626	5,274	127	14
March	360,536	643	2,530	174	8
April	355,974	679	586	220	3
May	387,033	696	9	317	0
June	391,920	717	0	377	0
July	409,254	726	0	412	0
Aug	410,673	720	0	399	0
Sept	376,847	698	0	314	0
Oct	373,457	680	782	241	4
Nov	345,639	645	2,834	167	9
Dec	352,402	628	5,204	147	11
Total	4,433,935	726	23,732	3,032	14

Building Energy Consumption = 287,740 (Btu/Sq Ft/Year)   Floor Area = 60,840 (Sq Ft)
Source Energy Consumption = 288,947 (Btu/Sq Ft/Year)

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 3
MOD CONFIG - BLDG 300 MINUS NEW CHIL PLT

------------------------------------ M O N T H L Y   E N E R G Y   C O N S U M P T I O N ------------------------------------

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	243,097	532	4,478	51	12
Feb	224,201	535	3,581	53	11
March	266,268	569	1,645	97	6
April	274,584	625	482	134	3
May	315,753	663	95	201	2
June	323,682	688	0	245	0
July	347,964	697	0	295	0
Aug	351,172	695	0	292	0
Sept	315,554	671	33	224	1
Oct	293,754	633	552	149	2
Nov	253,297	566	1,814	91	6
Dec	250,829	537	3,442	66	8
Total	3,460,157	697	16,123	1,896	12

Building Energy Consumption = 220,607 (Btu/Sq Ft/Year)   Floor Area = 60,840 (Sq Ft)
Source Energy Consumption = 221,427 (Btu/Sq Ft/Year)

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 4
MOD CONFIG - BLDG 300 MINUS NEW LIGHTING

----------------------------------- M O N T H L Y   E N E R G Y   C O N S U M P T I O N -----------------------------------

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	239,240	535	4,413	48	12
Feb	218,464	540	3,512	48	11
March	257,005	582	1,615	92	6
April	258,996	638	471	132	3
May	298,098	668	96	201	2
June	304,984	690	0	247	0
July	331,335	701	0	298	0
Aug	333,978	699	0	295	0
Sept	295,765	672	34	226	1
Oct	276,112	635	544	147	2
Nov	244,796	578	1,785	86	6
Dec	243,175	547	3,379	60	8
Total	3,301,951	701	15,848	1,879	12

Building Energy Consumption = 211,280 (Btu/Sq Ft/Year)   Floor Area = 60,840 (Sq Ft)
Source Energy Consumption = 212,085 (Btu/Sq Ft/Year)

APPENDIX C

ECO COST ESTIMATES

CONSTRUCTION COST ESTIMATE BREAKDOWN

CONTRACTOR	ADDRESS
EMC ENGINEERS INC.	2750 SOUTH WADSWORTH BLVD., #C-200, DENVER, CO 80227

CONTRACT FOR (Work to be performed)	PROPOSED TOTAL CONTRACT PRICE
VARIABLE AIR VOLUME SYSTEMS ON AHUs - BLDG 300	

PURCHASE REQUEST NUMBER	PROJECT NUMBER	WORK LOCATION
		WHITE SANDS MISSILE RANGE, NEW MEXICO

Line No.	Item (1)	Unit of Measure (2)	Quantity (3)	MATERIAL COST Unit (4)	MATERIAL COST Total (5)	LABOR COSTS Manhours Mandays (6)	LABOR COSTS Average Rate (7)	LABOR COSTS Total (8)	Other Direct Costs (9)	Line Total (10)
	Main Building, West Addition, and East Addition									
	Demolition (Mixing Boxes, T-stats, & Ductwork)	EA	84			2.00	20.58	3457.44		$3,457.44
	Install Variable Frequency Drives - Main Bldg.	EA	3	14486	43458	50.00	27.60	4140.00		$47,598.00
	Install Variable Frequency Drives - West Addition	EA	2	5444	10888	40.00	27.60	2208.00		$13,096.00
C-1	Install Variable Frequency Drives - East Addition	EA	2	7073	14145	40.00	27.60	2208.00		$16,353.00
	Ductwork Transitions for VAV Boxes	EA	84	50	4200	3.00	27.60	6955.20		$11,155.20
	Dual Duct VAV Mixing Boxes	EA	74	563	41625	3.00	27.63	6133.86		$47,758.86
	Single Zone VAV Terminal Units	EA	10	480	4800	4.00	27.63	1105.20		$5,905.20
	VAV Box Controls: DDC Controllers	EA	84	449	37695	2.00	27.60	4636.80		$42,331.80
	Velocity Sensors	EA	84	125	10500	1.00	27.60	2318.40		$12,818.40
	VAV Box Actuators	EA	158	94	14812.5	1.00	27.60	4360.80		$19,173.30
	Space Temperature Sensors	EA	84	63	5250	1.00	27.60	2318.40		$7,568.40
	Sensor Wiring	LF	4200	0.31	1312.5	0.06	27.60	6955.20		$8,267.70
	Power Wiring & Conduit	LF	4200	0.71	2992.5	0.08	27.60	9273.60		$12,266.10
	Subtotal									$247,749

Source: Means Electric & Mechanical Cost Data, 1993; Denver Electric Motor Sales & Service; Material costs include 25% overhead & profit; Labor Source: U.S. Dept. of Labor, General Wage Decision No. NM91-1

CONSTRUCTION COST ESTIMATE BREAKDOWN

CONTRACTOR: EMC ENGINEERS INC.	ADDRESS: 2750 SOUTH WADSWORTH BLVD., #C-200, DENVER, CO 80227
CONTRACT FOR (Work to be performed): VARIABLE AIR VOLUME SYSTEMS ON AHUs – BLDG 300	PROPOSED TOTAL CONTRACT PRICE:
PURCHASE REQUEST NUMBER:	PROJECT NUMBER:
	WORK LOCATION: WHITE SANDS MISSILE RANGE, NEW MEXICO

Line No.	Item (1)	Unit of Measure (2)	Quantity (3)	Material Cost: Unit (4)	Material Cost: Total (5)	Labor Costs: Manhours Mandays (6)	Labor Costs: Average Rate (7)	Labor Costs: Total (8)	Other Direct Costs (9)	Line Total (10)
	Main Bldg, West Addition, and East Addition (cont')									
	AHU Controls: Remote Control Units	EA	7	1125	7875	8.00	27.60	1545.60		$9,420.60
	Pressure Sensor Wiring	LF	1590	0.31	496.875	0.08	27.60	3510.72		$4,007.60
	Pressure Sensors	EA	7	250	1750	2.00	27.60	386.40		$2,136.40
	Control Programming	EA	3			8.00	50.00	1200.00		$1,200.00
	Field Test of Control System	EA	3			8.00	27.63	663.12		$663.12
	Check Air Flow on AHUs	EA	7			12.00	27.63	2320.92		$2,320.92
	Check Max. and Min. Air Flow on VAV Boxes	EA	84			6.00	27.63	13925.52		$13,925.52
	Subtotal									$281,424
	Contingency (10%)									$28,142
	TOTAL									$309,566

Source: Means Electric & Mechanical Cost Data, 1993; Denver Electric Motor Sales & Service; Material costs include 25% overhead & profit; Labor Source: U.S. Dept. of Labor, General Wage Decision No. NM91-1

CONSTRUCTION COST ESTIMATE BREAKDOWN

CONTRACTOR EMC ENGINEERS INC.	ADDRESS 2750 SOUTH WADSWORTH BLVD., #C-200, DENVER, CO 80227
CONTRACT FOR (Work to be performed) CONSOLIDATED CHILLER PLANT – BLDG 300	PROPOSED TOTAL CONTRACT PRICE
PURCHASE REQUEST NUMBER	PROJECT NUMBER
WORK LOCATION WHITE SANDS MISSILE RANGE, NEW MEXICO	

Line No.	Item (1)	Unit of Measure (2)	Quantity (3)	MATERIAL COST Unit (4)	MATERIAL COST Total (5)	LABOR COSTS Manhours Mandays (6)	LABOR COSTS Average Rate (7)	LABOR COSTS Total (8)	Other Direct Costs (9)	Line Total (10)
	CONSOLIDATED CHILLER PLANT									
	100 TON WTR CLD RECIP. CHILLER	EA	1	48500	48500	Cost includes Material & Labor w/ Overhead & Profit				$48,500.00
	Chilled Water and Condenser Water Piping (4 in.)	LF	180	10.33	1859.76	0.40	35.90	2584.80		$4,444.56
	Control Valves (4 in.)	EA	2	1071	2142.00	4.50	35.90	323.10		$2,465.10
	Shut-off Valves (4 in.)	EA	4	227	907.20	2.00	35.90	287.20		$1,194.40
	Pipe Insulation	LF	220	5.44	1197.50	0.20	36.15	1590.60		$2,788.10
	Variable Speed Drive Pumps	EA	2	1260	2520.00	8.00	35.90	574.40		$3,094.40
	Electrical (Motor Starters, Conduit, etc.)	EA	1	3780	3780.00	Cost includes Material & Labor w/ Overhead & Profit				$3,780.00
	CONTINGENCY (10%)									$6,627
	Source: Means Mechanical Cost Data, 1993									
	TOTAL THIS SHEET									$72,893

CONSTRUCTION COST ESTIMATE BREAKDOWN

CONTRACTOR: EMC ENGINEERS INC.

ADDRESS: 2750 SOUTH WADSWORTH BLVD., #C-200, DENVER, CO 80227

CONTRACT FOR (Work to be performed): CHILLER PLANT WITH THERMAL STORAGE – BLDG 300

PROPOSED TOTAL CONTRACT PRICE:

PURCHASE REQUEST NUMBER:

PROJECT NUMBER:

WORK LOCATION: WHITE SANDS MISSILE RANGE, NEW MEXICO

Line No.	Item (1)	Unit of Measure (2)	Quantity (3)	MATERIAL COST Unit (4)	MATERIAL COST Total (5)	LABOR COSTS Manhours Mandays (6)	LABOR COSTS Average Rate (7)	LABOR COSTS Total (8)	Other Direct Costs (9)	Line Total (10)
	CHILLER PLANT W/ THERMAL STORAGE									
	1,000 TON-HR THERMAL STORAGE TANK & CONNECTIONS	TON-HR	1000	75	75000	Material & Labor				$75,000
	CONTINGENCY (10%)									$7,500
	TOTAL THIS SHEET									$82,500

Source: EPRI Thermal Storage Applications Research Center, Material & Labor Costs Include 25% Overhead & Profit

CONSTRUCTION COST ESTIMATE BREAKDOWN

CONTRACTOR EMC ENGINEERS INC.	ADDRESS 2750 SOUTH WADSWORTH BLVD., #C-200, DENVER, CO 80227
CONTRACT FOR (Work to be performed) ENERGY EFFICIENT LIGHTING IN BLDG. 300	PROPOSED TOTAL CONTRACT PRICE
PURCHASE REQUEST NUMBER	PROJECT NUMBER
WORK LOCATION WHITE SANDS MISSILE RANGE, NEW MEXICO	

Line No.	Item (1)	Unit of Measure (2)	Quantity (3)	MATERIAL COST Unit (4)	MATERIAL COST Total (5)	LABOR COSTS Manhours Mandays (6)	LABOR COSTS Average Rate (7)	LABOR COSTS Total (8)	Other Direct Costs (9)	Line Total (10)
	INSTALL ENERGY EFFICIENT LAMPS AND BALLASTS									
	4 FT. ENERGY EFFICIENT LAMPS	EA	2545	2.19	5573.55	0.09	27.60	6181.30		$11,754.85
	ENERGY EFFICIENT BALLASTS	EA	1245	14.06	17504.70	0.85	27.60	29242.06		$46,746.76
	DIMMING BALLASTS	EA	18	21.75	391.50	0.85	27.60	422.78		$814.28
	TOTAL THIS SHEET									$59,315.88

Material Source: Lightbulb Supply Co., Denver, CO; Prices Include 25% Overhead & Profit; Labor Source: U.S. Dept. of Labor, General Wage Decision No. NM91-1

APPENDIX D

LIGHTING CALCULATIONS

BLDG P300 LIGHTING CALCULATIONS

ZONE #1

INSTALLED FIXTURES (IF):

51 X 96 Watts =	4896 Watts
25 X 71 Watts =	1775 Watts
Total Watts :	6671 Watts

1.5 Watts/SF is assummed for existing lighting
3595 SF is the zone floor area
76 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
5393 Watts (observed) /
6671 Watts (installed fixtures)
= 0.81

INSTALLED FIXT. X EFFECT. LAMP FACTOR
41 Effective # of existing standard fixtures
20 Effective # of low-wattage fixtures
= 61 Total Fixtures

COST ESTIMATE:
82 Replacement Lamps
40 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.21 Watts/SF

ZONE #2

INSTALLED FIXTURES (IF):

25 X 96 Watts =	2400 Watts
13 X 71 Watts =	923 Watts
Total Watts :	3323 Watts

1.7 Watts/SF is assummed for existing lighting
1595 SF is the zone floor area
38 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
2712 Watts (observed) /
3323 Watts (installed fixtures)
= 0.82

INSTALLED FIXT. X EFFECT. LAMP FACTOR
20 Effective # of existing standard fixtures
11 Effective # of low-wattage fixtures
= 31 Total Fixtures

COST ESTIMATE:
41 Replacement Lamps
20 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.38 Watts/SF

ZONE #3

INSTALLED FIXTURES (IF):

55 X 96 Watts =	5280 Watts
28 X 71 Watts =	1988 Watts
Total Watts :	7268 Watts

0.6 Watts/SF is assummed for existing lighting
2640 SF is the zone floor area
83 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
1584 Watts (observed) /
7268 Watts (installed fixtures)
= 0.22

INSTALLED FIXT. X EFFECT. LAMP FACTOR
12 Effective # of existing standard fixtures
6 Effective # of low-wattage fixtures
= 18 Total Fixtures

COST ESTIMATE:
24 Replacement Lamps
12 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
0.49 Watts/SF

BLDG P300 LIGHTING CALCULATIONS

ZONE #4

INSTALLED FIXTURES (IF):

25 X 96 Watts = 2400 Watts
12 X 71 Watts = 852 Watts
Total Watts : 3252 Watts

1.7 Watts/SF is assummed for existing lighting
1595 SF is the zone floor area
37 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):

2712 Watts (observed) /
3252 Watts (installed fixtures)
= 0.83

INSTALLED FIXT. X EFFECT. LAMP FACTOR

21 Effective # of existing standard fixtures
10 Effective # of low-wattage fixtures
= 31 Total Fixtures

COST ESTIMATE:

42 Replacement Lamps
21 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:

1.37 Watts/SF

ZONE #5

INSTALLED FIXTURES (IF):

49 X 96 Watts = 4704 Watts
25 X 71 Watts = 1775 Watts
Total Watts : 6479 Watts

2.0 Watts/SF is assummed for existing lighting
2640 SF is the zone floor area
74 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):

5280 Watts (observed) /
6479 Watts (installed fixtures)
= 0.81

INSTALLED FIXT. X EFFECT. LAMP FACTOR

40 Effective # of existing standard fixtures
20 Effective # of low-wattage fixtures
= 60 Total Fixtures

COST ESTIMATE:

80 Replacement Lamps
40 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:

1.62 Watts/SF

ZONE #6

INSTALLED FIXTURES (IF):

64 X 96 Watts = 6144 Watts
32 X 71 Watts = 2272 Watts
Total Watts : 8416 Watts

2.0 Watts/SF is assummed for existing lighting
3280 SF is the zone floor area
96 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):

6560 Watts (observed) /
8416 Watts (installed fixtures)
= 0.78

INSTALLED FIXT. X EFFECT. LAMP FACTOR

50 Effective # of existing standard fixtures
25 Effective # of low-wattage fixtures
= 75 Total Fixtures

COST ESTIMATE:

100 Replacement Lamps
50 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:

1.62 Watts/SF

BLDG P300 LIGHTING CALCULATIONS

ZONE #8

INSTALLED FIXTURES (IF):

30 X 96 Watts =	2880 Watts
15 X 71 Watts =	1065 Watts
Total Watts :	3945 Watts

1.9 Watts/SF is assummed for existing lighting
1595 SF is the zone floor area
45 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
3031 Watts (observed) /
3945 Watts (installed fixtures)
= 0.77

INSTALLED FIXT. X EFFECT. LAMP FACTOR
23 Effective # of existing standard fixtures
12 Effective # of low-wattage fixtures
= 35 Total Fixtures

COST ESTIMATE:
46 Replacement Lamps
23 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.54 Watts/SF

ZONE #9

INSTALLED FIXTURES (IF):

56 X 96 Watts =	5376 Watts
28 X 71 Watts =	1988 Watts
Total Watts :	7364 Watts

2.0 Watts/SF is assummed for existing lighting
2640 SF is the zone floor area
84 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
5280 Watts (observed) /
7364 Watts (installed fixtures)
= 0.72

INSTALLED FIXT. X EFFECT. LAMP FACTOR
40 Effective # of existing standard fixtures
20 Effective # of low-wattage fixtures
= 60 Total Fixtures

COST ESTIMATE:
80 Replacement Lamps
40 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.62 Watts/SF

ZONE #10

INSTALLED FIXTURES (IF):

25 X 96 Watts =	2400 Watts
12 X 71 Watts =	852 Watts
Total Watts :	3252 Watts

1.7 Watts/SF is assummed for existing lighting
1595 SF is the zone floor area
37 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
2712 Watts (observed) /
3252 Watts (installed fixtures)
= 0.83

INSTALLED FIXT. X EFFECT. LAMP FACTOR
21 Effective # of existing standard fixtures
10 Effective # of low-wattage fixtures
= 31 Total Fixtures

COST ESTIMATE:
42 Replacement Lamps
21 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.37 Watts/SF

BLDG P300 LIGHTING CALCULATIONS

ZONE #11

INSTALLED FIXTURES (IF):		EFFECTIVE LAMP FACTOR (ELF):
51 X 96 Watts =	4896 Watts	3960 Watts (observed) /
25 X 71 Watts =	1775 Watts	6671 Watts (installed fixtures)
Total Watts :	6671 Watts	= 0.59

	INSTALLED FIXT. X EFFECT. LAMP FACTOR
1.5 Watts/SF is assummed for existing lighting	30 Effective # of existing standard fixtures
2640 SF is the zone floor area	15 Effective # of low-wattage fixtures
76 Total # of Fixtures	= 45 Total Fixtures

COST ESTIMATE:	TRACE 600 INPUT FOR LIGHTING ECO:
60 Replacement Lamps	1.21 Watts/SF
30 Replacement Ballasts	

ZONE #12

INSTALLED FIXTURES (IF):		EFFECTIVE LAMP FACTOR (ELF):
55 X 96 Watts =	5280 Watts	4404 Watts (observed) /
27 X 71 Watts =	1917 Watts	7197 Watts (installed fixtures)
Total Watts :	7197 Watts	= 0.61

	INSTALLED FIXT. X EFFECT. LAMP FACTOR
2.0 Watts/SF is assummed for existing lighting	34 Effective # of existing standard fixtures
2202 SF is the zone floor area	17 Effective # of low-wattage fixtures
82 Total # of Fixtures	= 50 Total Fixtures

COST ESTIMATE:	TRACE 600 INPUT FOR LIGHTING ECO:
68 Replacement Lamps	1.62 Watts/SF
34 Replacement Ballasts	

ZONE #13

INSTALLED FIXTURES (IF):		EFFECTIVE LAMP FACTOR (ELF):
57 X 96 Watts =	5472 Watts	7560 Watts (observed) /
29 X 71 Watts =	2059 Watts	7531 Watts (installed fixtures)
Total Watts :	7531 Watts	= 1.00

	INSTALLED FIXT. X EFFECT. LAMP FACTOR
2.0 Watts/SF is assummed for existing lighting	57 Effective # of existing standard fixtures
3780 SF is the zone floor area	29 Effective # of low-wattage fixtures
86 Total # of Fixtures	= 86 Total Fixtures

COST ESTIMATE:	TRACE 600 INPUT FOR LIGHTING ECO:
114 Replacement Lamps	1.62 Watts/SF
57 Replacement Ballasts	

BLDG P300 LIGHTING CALCULATIONS

ZONE #14

INSTALLED FIXTURES (IF):

54 X 96 Watts =	5184 Watts	
27 X 71 Watts =	1917 Watts	
Total Watts :	7101 Watts	

2.0 Watts/SF is assummed for existing lighting
3688 SF is the zone floor area
81 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
7376 Watts (observed) /
7101 Watts (installed fixtures)
= 1.04

INSTALLED FIXT. X EFFECT. LAMP FACTOR
56 Effective # of existing standard fixtures
28 Effective # of low-wattage fixtures
= 84 Total Fixtures

COST ESTIMATE:
108 Replacement Lamps
54 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.62 Watts/SF

ZONE #15

INSTALLED FIXTURES (IF):

84 X 96 Watts =	8064 Watts	
42 X 71 Watts =	2982 Watts	
Total Watts :	11046 Watts	

1.9 Watts/SF is assummed for existing lighting
4089 SF is the zone floor area
126 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
7769 Watts (observed) /
11046 Watts (installed fixtures)
= 0.70

INSTALLED FIXT. X EFFECT. LAMP FACTOR
59 Effective # of existing standard fixtures
30 Effective # of low-wattage fixtures
= 89 Total Fixtures

COST ESTIMATE:
118 Replacement Lamps
74 Replacement Ballasts (18 Dimming Ballasts)

TRACE 600 INPUT FOR LIGHTING ECO:
1.54 Watts/SF

ZONE #16

INSTALLED FIXTURES (IF):

94 X 96 Watts =	9024 Watts	
46 X 71 Watts =	3266 Watts	
Total Watts :	12290 Watts	

2.0 Watts/SF is assummed for existing lighting
6002 SF is the zone floor area
140 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
12004 Watts (observed) /
12290 Watts (installed fixtures)
= 0.98

INSTALLED FIXT. X EFFECT. LAMP FACTOR
92 Effective # of existing standard fixtures
45 Effective # of low-wattage fixtures
= 137 Total Fixtures

COST ESTIMATE:
184 Replacement Lamps
92 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.62 Watts/SF

BLDG P300 LIGHTING CALCULATIONS

ZONE #17

INSTALLED FIXTURES (IF):

55 X 96 Watts =	5280 Watts
28 X 71 Watts =	1988 Watts
Total Watts :	7268 Watts

2.0 Watts/SF is assummed for existing lighting
3431 SF is the zone floor area
83 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
6862 Watts (observed) /
7268 Watts (installed fixtures)
= 0.94

INSTALLED FIXT. X EFFECT. LAMP FACTOR
52 Effective # of existing standard fixtures
26 Effective # of low-wattage fixtures
= 78 Total Fixtures

COST ESTIMATE:
104 Replacement Lamps
52 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.62 Watts/SF

ZONE #18

INSTALLED FIXTURES (IF):

116 X 96 Watts =	11136 Watts
58 X 71 Watts =	4118 Watts
Total Watts :	15254 Watts

1.5 Watts/SF is assummed for existing lighting
5762 SF is the zone floor area
174 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
8643 Watts (observed) /
15254 Watts (installed fixtures)
= 0.57

INSTALLED FIXT. X EFFECT. LAMP FACTOR
66 Effective # of existing standard fixtures
33 Effective # of low-wattage fixtures
= 99 Total Fixtures

COST ESTIMATE:
132 Replacement Lamps
66 Replacement Ballasts

TRACE 600 INPUT FOR LIGHTING ECO:
1.21 Watts/SF

ZONE #19

INSTALLED FIXTURES (IF):

28 X 96 Watts =	2688 Watts
14 X 71 Watts =	994 Watts
Total Watts :	3682 Watts

1.9 Watts/SF is assummed for existing lighting
2077 SF is the zone floor area
42 Total # of Fixtures

EFFECTIVE LAMP FACTOR (ELF):
3946 Watts (observed) /
3682 Watts (installed fixtures)
= 1.07

INSTALLED FIXT. X EFFECT. LAMP FACTOR
30 Effective # of existing standard fixtures
15 Effective # of low-wattage fixtures
= 45 Total Fixtures

COST ESTIMATE:
56 Replacement Lamps
28 Replacement Ballasts

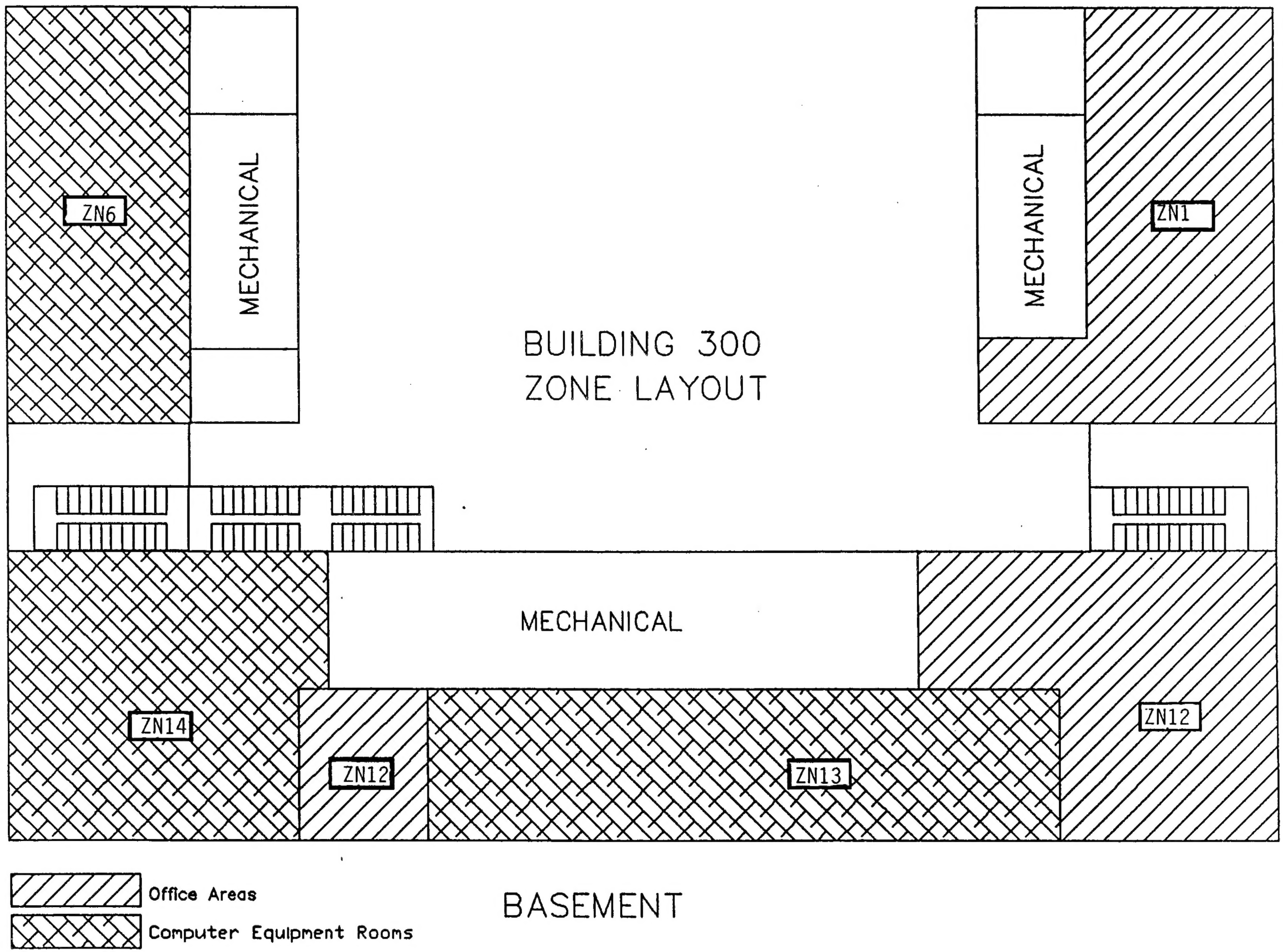
TRACE 600 INPUT FOR LIGHTING ECO:
1.54 Watts/SF

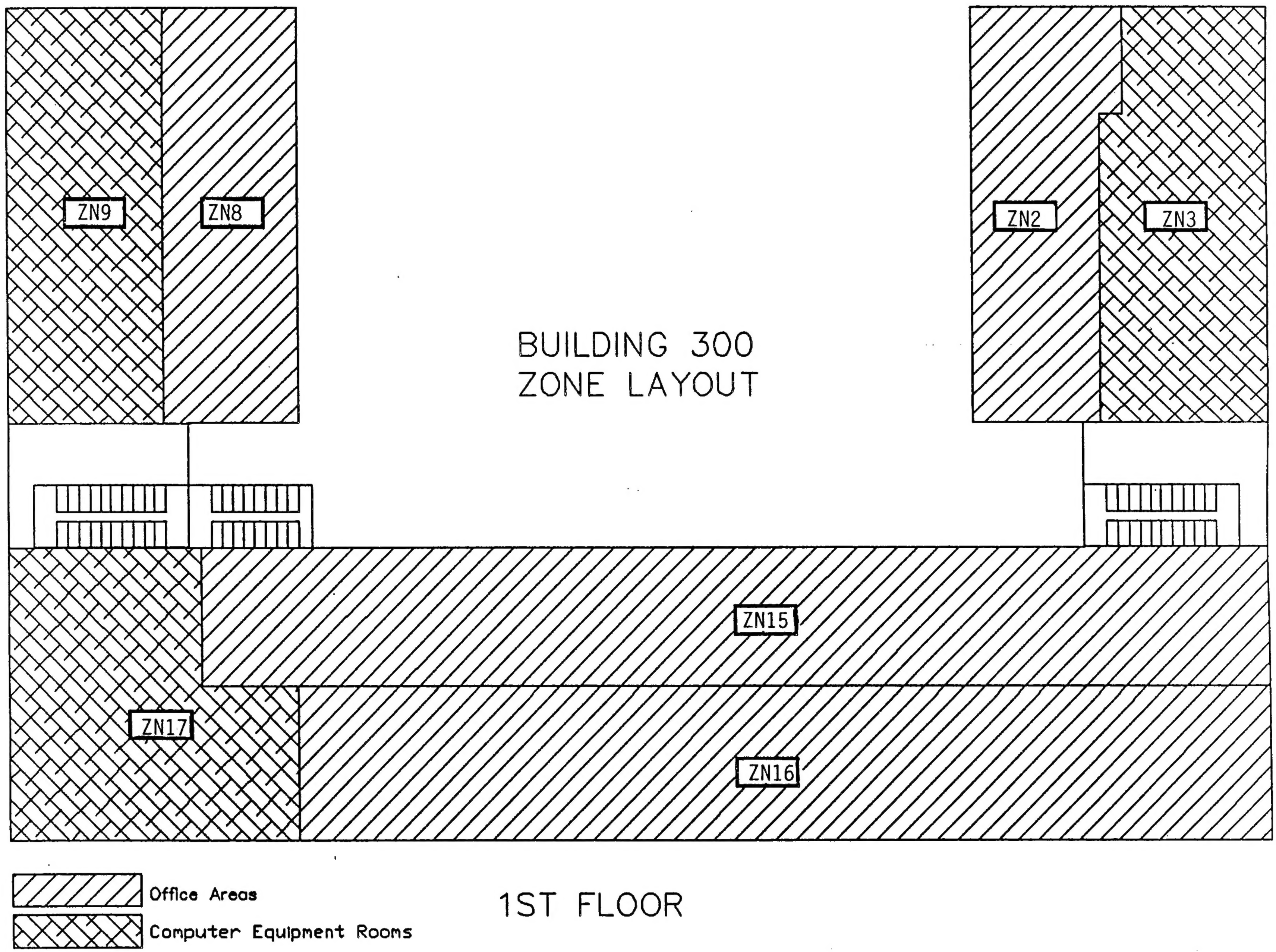
BLDG P300 LIGHTING CALCULATIONS

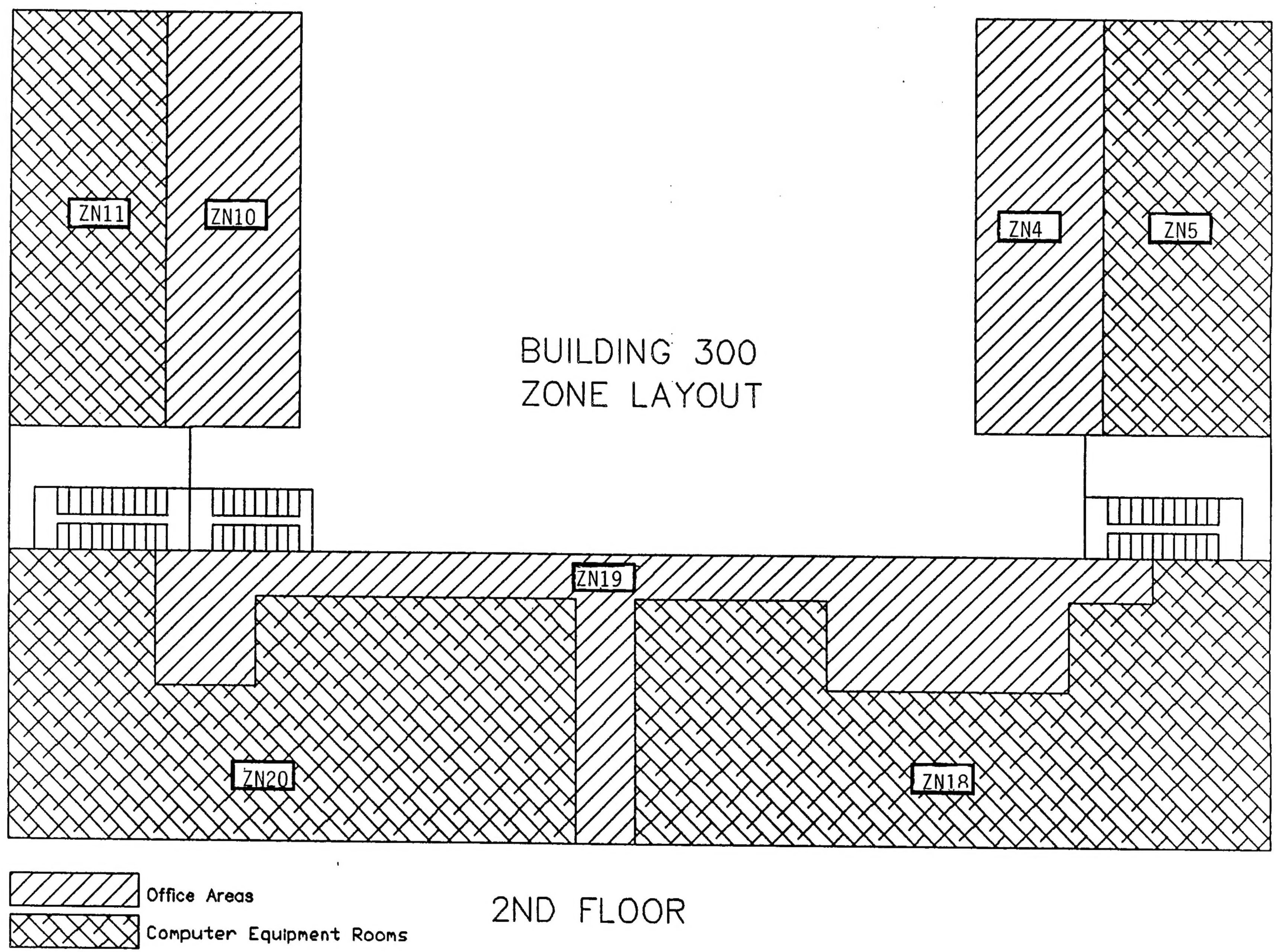
ZONE #20

INSTALLED FIXTURES (IF):		EFFECTIVE LAMP FACTOR (ELF):	
92 X 96 Watts =	8832 Watts	11362 Watts (observed) /	
46 X 71 Watts =	3266 Watts	12098 Watts (installed fixtures)	
Total Watts =	12098 Watts	=	0.94
		INSTALLED FIXT. X EFFECT. LAMP FACTOR	
2.0 Watts/SF is assummed for existing lighting		86 Effective # of existing standard fixtures	
5681 SF is the zone floor area		43 Effective # of low-wattage fixtures	
138 Total # of Fixtures		=	130 Total Fixtures

COST ESTIMATE:	TRACE 600 INPUT FOR LIGHTING ECO:
172 Replacement Lamps	1.62 Watts/SF
86 Replacement Ballasts	


BUILDING 300
ZONE LAYOUT
MECHANICAL
MECHANICAL
MECHANICAL
ZN6
ZN1
ZN14
ZN12
ZN13
ZN12
Office Areas
Computer Equipment Rooms
BASEMENT


BUILDING 300
ZONE LAYOUT
ZN9
ZN8
ZN2
ZN3
ZN15
ZN17
ZN16
Office Areas
Computer Equipment Rooms
1ST FLOOR


BUILDING 300
ZONE LAYOUT
ZN11
ZN10
ZN4
ZN5
ZN19
ZN20
ZN18
Office Areas
Computer Equipment Rooms
2ND FLOOR